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Vertical Air Pump of the U. S. S. "Bancroft."

The illustration on this page represents the air pump furnished for the U. S. S. "Bancroft," by M. T. Davidson, 43–53 Keap street, Brooklyn, N. Y., and 77 Liberty street, New York City.

It consists of a double-acting steam cylinder, 8 inches in diameter, driving two vertical single-acting pumps with buckets 14 inches diameter. Vertical single-acting air pumps have always been in favor, for obvious reasons, and the arrangement shown provides, very neatly, for balancing and driving them with a double-acting steam cylinder.

The pumps are of ordinary construction. The inlet may be from either side, and the discharge is into the upper channel by a floating top.

The valve motion for the steam cylinder is of the regular "Davidson" type. In the trial trip of the "Bancroft," this pump is credited with excellent performance. Several of this type of pump of various sizes have been placed by the builder on the better classes of steam yachts, and for use for stationary engines, the small space occupied, amongst other features, commending their employment.

Machine Shop Milling Practice—VI.

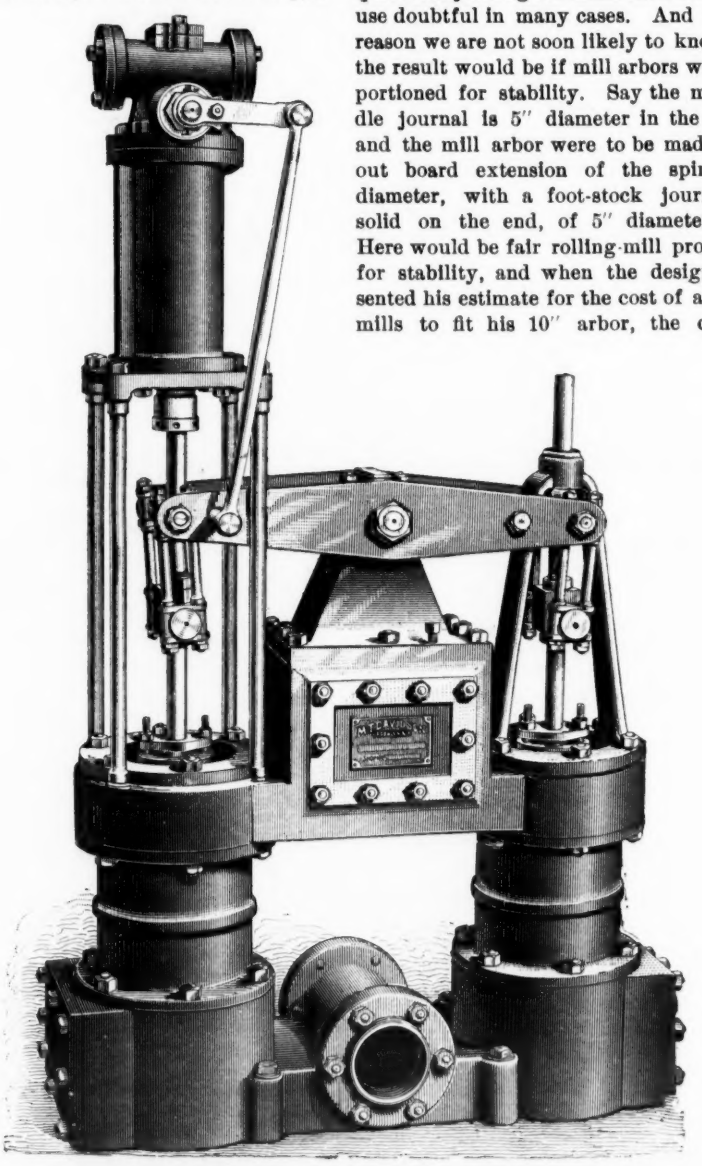
By Horace L. Arnold.

The first essential for ideal milling is machine stability. The cutter arbor should be incapable of deflection or "springing," and the advance of the work toward the mill teeth should be absolutely uniform.

The per tooth cut is so small a part of an inch, provided it is taken share and share alike by each tooth of the mill, that a thousandth of an inch irregularity in the feed, or spring in the arbor, or yield of the arbor housing, will make one tooth of the mill pass the work idle, and cause some succeeding tooth to do twice its allotted work, and hence install such a cycle of changes from the normal action of the whole machine as to produce a result compounded of so many variables, that Rankine himself would find difficulty in predicting the mathematical outcome, and the best practical man in the business would simply declare the truth in saying no one could predict the result.

Supposing the bed to be driven at an absolutely unvarying rate, arbor deflection at once sets up a series of vibratory movements of the mills, which entirely destroys the uniformity of cut.

And it may here be noted that in no solitary example which has come under my own observation is any mill arbor suitably supported against vibration. There are two cases of the mill arbor; first, where the mill arbor is supported from the head-stock end only, as shown in the full lines in Fig. 34 (page 2), or by both head and foot stock supports, as shown by both full and dotted lines in the same figure. In a very great number of cases the foot-stock support is not so good as is shown in Fig. 34, the out board or foot-stock support being narrowed down to the fraction of an inch diameter of a taper center at the greatest area point of its entrance into the mill arbor which the center is designed to support. In either case there is a sudden weakening of the support of the mill *M*, Fig. 34, at the points *R*, R^1, which is most unfavorable to stability. This reduction is always very great. In the heaviest milling I have so far seen it is from $5\frac{1}{2}''$ journal diameter to about $3\frac{1}{4}''$ or something less for the arbor diameter, that is to say, from a stability factor of 30.25 to 10.47, or from 1 down to $\frac{1}{4}$, at the head-stock end of the arbor, and at the foot-stock end the arbor journal in the foot or tail spindle was only 2″, making the reduction at that end from 30.25 to 4, or from 1 to less than $\frac{1}{4}$. Were we to design any other piece of work for stable rotation, we would, of course, have no such small sections to take the heaviest strains. Fancy a train of rolling-mill rolls necked down outside the housings in such a manner. On the contrary, the most inexperienced designer would keep his roll section outside of the housings at least equal to the journal diameter within the housings; in practice, as I hardly need say, the diameter of the smallest part of the roll outside of the housing is always much greater than the journal diameter in the working sections. Hence, I think it safe to say that the universal practice is entirely wrong so far as arbor support goes. In all cases the reduction of diameter at *R* and R^1 is very great, and, until the whole present practice of mill making and mill arbor using is changed in a manner which now appears impossible, or at least commercially impossible, even a fair approach to stability of mill arbor support seems impossible, because increase of mill diameter costs a great deal of money per inch, and mills are now regarded as quite costly enough to make their economical use doubtful in many cases. And for this reason we are not soon likely to know what the result would be if mill arbors were proportioned for stability. Say the mill spindle journal is 5″ diameter in the journal, and the mill arbor were to be made a solid out board extension of the spindle 10″ diameter, with a foot-stock journal still solid on the end, of 5″ diameter again. Here would be fair rolling-mill proportions for stability, and when the designer presented his estimate for the cost of a gang of mills to fit his 10″ arbor, the customer would undoubtedly prefer to imperil the stability of his mill support rather than that of his bank account, and the stability design would be shelved, and the customary small arbor and mills go into the job. There can be little doubt, however, that the practical or shop results of the use of such a proportion of mill arbor diameter to spindle journal diameter would be very gratifying in every way, and should we ever see such a vast variation from the best present practice, it might even prove economical by the test of the prime cost book. At all events, it seems mechanically certain that we cannot look for any such thing as stable mill support with the present proportions, and it certainly seems of little use to augment the diameter of milling machine spindles while they are to drive mill arbors of only $\frac{1}{2}$ or $\frac{1}{4}$ the section of the spindle journals.



Vertical Air Pump of the U. S. S. "Bancroft."

With the radial or end mill this reduction at *R*, Fig. 34, may or may not be present; in the best common practice it is not present. The mill body is screwed directly to the greatly enlarged spindle nose, and all possible stability to be gained from a one-end support is had. The radial mill cannot have a double-end support, but it is probably far better supported for the work it has to do than is the equivalent axial mill, because the radial mill has only a very small part of the pressure to sustain that falls on an axial mill covering the same width of cut.

To secure a uniform advance of the work table toward the cutters is a matter of great difficulty, and the screw in some form has been almost universally adopted as the most suitable mechanical device for this purpose, though not in all cases, and not in some very successful examples. Whether the screw shall be long and the nut short, or both screw and nut of the same length, or the screw very short and the nut the whole length of the bed, are questions answered differently by different milling machine makers. The Pratt & Whitney Company have, in their latest work, adopted the long nut and short screw first introduced, so far as I know, many years since at Colt's Armory by Mr. Root, long dead, who was in his day a very able and progressive mechanic.

Mr. F. A. Pratt kindly gave me his personal recollections of the development of milling machine feed mechanisms, as follows:

"Mr. E. K. Root, president for years of the Colt Arms Co., Hartford, Conn., was one of the finest mechanics I ever met, as well as a man of great business ability, and he had also a great general knowledge of things, and was very original as well as very sound in his applications of his remarkable store of information to the practical development of means and processes in the armory. I admired him greatly, and used to pass all of the time I could with him; I saw him not only in the armory, where I was, at the time of which I speak, employed, but often went to his house evenings; his conversation was most instructive to a young mechanic, such as I was at that time, and everything he did was a success so far as I can remember. He was a practical machinist himself, a native of Connecticut, and before he was at Colt's Armory he was for a long time at Collinsville, where he brought the ax manufacturing business to a point of great success. He died, I think, at the age of 68, about 1862. It was Mr. Root who first applied to the milling machine table the feed which we call here the 'short drive'—a short screw of very large diameter, lying under the milling machine table, and working in a partial long nut, or concave spiral rack, longer than the longest feed-table travel, which was cut out of the solid in the middle of the under side of the feed table. I do not know that this device of a very long partial nut and a very large short screw had ever been used as a driving mechanism previously; it may have been, or it may have been original with Mr. Root. I do not remember now ever having heard it mentioned except in connection with Mr. Root's name. The first milling machine having this work-table drive was made at Colt's Armory from Mr. Root's designs in 1853 or 1854. Before that time the armory

milling machines were made, all of them, I think, by Robins & Lawrence, of Windsor, Vermont. There may have been some made at the Springfield, Mass., armory, but I think all the Springfield machines were Robins & Lawrence build. The Chicopee Company (the Ames Company, at Chicopee Falls) built some, but I think later than the time I speak of, though I am not very sure; this was forty years ago, and I cannot be very positive about things so far back. The Robins & Lawrence milling machine table was driven, if I remember correctly, by a feed cone belt from the belt spindle down to a worm shaft cone below; this worm shaft worm drove a horizontal worm gear on a vertical worm gear shaft, and the vertical worm gear shaft reached up, and had on its top end a small bevel pinion which drove a large bevel gear on a horizontal pinion shaft under the work table, and the pinion on this shaft worked in a rack on the under side of the work table; the large bevel gear on the pinion shaft was on the head stock side of the table, and at the foot-stock side the rack pinion shaft had a hand crank, by which the workman could run the work table back after the 'knock off' had put the worm gear out of gear with the worm at the end of the mill cut. All milling machines up to the time of Mr. Root's introduction of the 'short drive' in 1852 or 1853, I cannot be sure which, had rack and pinion driven work tables, I think. I remember the Root machine perfectly; I did the planing on some of the first machines, which were built at Colt's Armory in 1854. There was a great deal of doubt among the hands about the successful use of a screw for driving a milling machine table; it was thought it would give a slow return by hand, which would greatly affect the output of the machine. Those who held this opinion did not stop to think of the very small proportion relatively of the time of the hand return action of the table, made either by the rack and pinion or the screw, to the time used in taking the work out of the fixture and putting it in, and making the mill cut. The machines were a success from the first, and were so great an improvement over the Robins & Lawrence that the latter went out of manufacture almost immediately, though they had been previously considered beyond improvement both here and in England, the Enfield Armory being wholly equipped with the Robins & Lawrence machines, as well as all the armories in the United States. The spiral concave rack was cut out of the solid in the screw-cutting lathe with a boring bar, and the large short screw, about 6″ diameter, 8″ or 10″ long, square thread, about ¾″ or 1″ pitch, was driven directly by a worm driving a worm gear cut out of the solid on the short screw, and, of course, this worm gear had to be smaller in diameter than the bottom of the screw thread; this makes the power applied at a smaller radius than that at which the work is taken off, and gives rise to a good deal of friction, which is, however, not of much account when the cut is light and the feed is slow. The screw is held stationary against end motion by shoulders against its journal bearings, and the whole arrangement was very simple, strong and effective; and the very large wearing surface offered by the coarse pitch screw threads made this drive durable, as the lubrication was constant from the lower side of the screw running in an oil cellar. That was the end of the rack and pinion feed in milling machines, but still the Root short drive never came into extensive use. It is still in use at Colt's, and Mr. Cook, in his machine shop in Colt's Armory, still builds machines of the original pattern. I believed the small, long screw and a nut of ordinary length fully as good as the short drive, and less open to the charge of needless friction; and when we went to Lincoln's in 1854—Mr. Whitney and myself—we at once began the manufacture of machine tools, all of which I designed. The Lincoln shops were mainly foundry at that time; they made one machine tool, a medium-sized planer; they made some punching presses, and a very great many molasses 'gates,' or faucets. There in 1855 I brought out the first long screw table feed for a milling machine (screw about 1¼″ diameter) and that machine has been only very slightly altered since. It was and is known as the 'Lincoln miller,' and we have built, I think, over 5,000 of them, and a very large number have been built from the same design by other parties." In reply to a question, Mr. Pratt further said: "Yes, for a time the 'Phœnix' machine tools—the Lincoln shops were known as the 'Phœnix'—were the leading small tools of this country, perhaps for six or eight years or so; then we began for ourselves, Mr. Whitney and myself, and from that time the 'Phœnix' tools declined in popularity, and now they are running mainly on foundry work again, I think, same as they were when we first went to Lincoln's."

Again answering, Mr. Pratt said: "Yes, we have adopted the Root 'short drive' in our heaviest milling machines; so far there is no ideal drive for a heavy milling machine work table. The drive should be perfectly smooth, very powerful, and absolutely rigid, with no 'backlash' or looseness of parts whatever. The work is very severe, no matter which way the mills are run. We put a ball-bearing thrust collar at the ends of the short screw to relieve the friction; that helps, but the square thread cannot have its lost motion taken up by any adjustment yet brought out, that is, taken up *perfectly*, so that there is absolutely no lost motion. With a heavy machine, if the cut is heavy

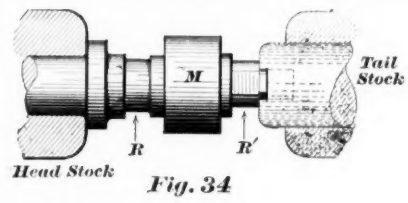


Fig. 34

then the work-table advance is, I think, very nearly uniform with the work fed with the mill rotation, but with a light cut, where the work on the feed mechanism is less, the table advance is not likely to be so invariable. If the short screw is used the power must either be applied at a circumference of smaller radius than the radius of work delivery, or we must extend the screw shaft beyond the extreme limit of table travel, which is very awkward, and must then put a wheel on this shaft, which stands above the work table, if we are going to have a screw driver of any good size, which is more awkward still. The problem has not yet had a perfectly satisfactory solution."

Mr. Pratt further said: "There have been two noteworthy efforts made to overcome the 'backlash' in any train of mechanism; one is shown in the patent of Hugo Bilgram, No. 289,607, December 4, 1883, and the other is that of A. T. Gifford, patented November 17, 1885. Bilgram's idea is to use for a table drive in two directions, two totally independent trains of gearing which are alternately driven by the same belt, the belt being shifted from one to the other of the driving pulleys, which are the initial driving members of each train, at the end of each stroke; the result of this arrangement is that the *idle* train of gearing is driven by the working train from its *final* to its initial member, and hence when the idle train is made the driving train all of its teeth are already in contact on its driving side, and hence no jar due to slack in gearing can occur at the moment of reversal of table motion direction. Gifford's arrangement is intended specially for milling machines, and his idea is to drive with a rack and pinion on each side of the table (same as Professor Sweet in your issue of December 21, 1893) both the driving pinions being themselves worm driven; one pinion is rigidly connected with its worm gear driver, while the other is *friction* driven by its worm gear driver, and this friction-connected worm gear is given a faster motion than the rigidly connected worm gear, so that the friction connection gives a constant *over feed*, and the rigidly connected pinion acts as a holdback against this over feed, thus theoretically taking out all lost motion or 'backlash' in the table-driving train."

It may be interesting to note that Mr. Pratt also showed me a letter from a foreign correspondent, stating that an application for a German patent on a table drive was to be opposed on the ground of publicity given by Professor Sweet's "drive" suggestions in the AMERICAN MACHINIST of December 21st, mentioned in other places in this article.

The analogy between the Root short milling machine drive, and the well-known Sellers' planer table drive is at once noticeable; but, as is well known, the Sellers' planer drive is not without end shake, and cannot be adjusted readily, if at all.

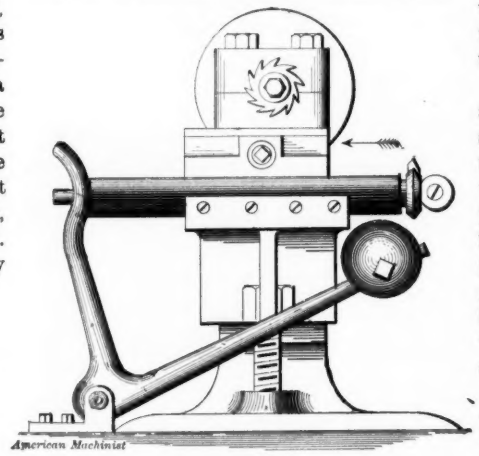


Fig. 35

There seems to be no way to make any screw or any rack and pinion drive exactly suitable for the milling machine. If the long screw and long nut (nut and screw of same length, this length somewhat in excess of the extreme length of table travel) are employed, then the wear of the nut and screw can be kept so nearly uniform for the whole length of both that the pitch of each will be kept the same by wear, then by dividing either the screw or the nut in the middle and introducing a means of varying the total length of either, the slack or lost motion may be taken up; *not*, however, in such a manner as to perfectly preserve the original wearing surfaces; but even in this case the drive must be located far below the top of the work table to give an adequate size of driver for the screw. Any form or modification of rack and pinion drive is open to the fault of lost motion through wear, and the strain on the drive due to actual work is so great as to make it extremely undesirable to add to it by any retarding device applied to the table; such a device is often applied to small milling machines and is extremely useful and efficient. A very late and very satisfactory (in operation) device of this class is shown in Fig. 35, which is an "impressionist" sketch from actual practice, which I saw in a large shop where everything is supposed to be of the best, and which was exhibited with a satisfaction which at once convinced me that it overcame what had been a real difficulty and annoyance. I did not take any measurements, as I had no desire to express the surprise I felt, but the wrought-iron bell crank and the globe weight of cast-iron were proportioned about as I have given them in Fig. 35, and it is evident the weight must resist the entire labor of the cut with an additional margin for overcoming friction, to be of any use. I was informed that a heavy spring had been tried without benefit. The superintendent of the job, who was designer of this noticeable effect, himself said it was "not very pretty but it did the work." It was in use on several machines, 4 or 5, I think, with light cuts, and improved both the output and quality of the work.

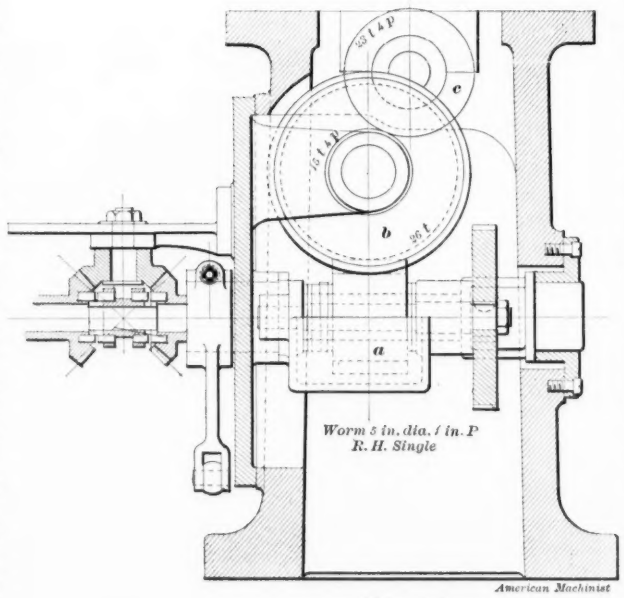


Fig. 36

Fig. 36 shows the Root short-drive details as applied to the Pratt & Whitney No. 7 slabbing machine, or double-head milling machine. The first driver shown is the worm *a* at the bottom, 5″ diameter, 1″ pitch, which drives the worm gear *b* of 26 teeth, which carries the 15-tooth, 4 pitch pinion, which drives the 23-tooth, 4 pitch gear *c* fast on the short screw. This pinion is, of course, 6¼″ outside diameter, which would make the diameter of the screw probably 7½″.

This drive has the very great construction advantage of being capable of a midway location in the machine, and also leaves the ends of the work table free from all projections or attachments of any sort. It is not so cheap, perhaps, as a large long screw and a short nut, and it would seem that its liabilities to wear are no less than those of a long screw with a short full circumference nut. The grand fault with any arrangement of the screw lies, as has already been fully pointed out in the columns of the AMERICAN MACHINIST by others, in the fact that unequal wear of a screw cannot be taken up by any rigid arrangement of nut adjustment, because with a screw of unequal dimensions at different points of its length a nut which fits in the small places will not pass the large places; a recent writer also gave a method of reducing a worn screw throughout to its smallest section, so that a nut could again be made to fit it, and Professor Sweet gave an "impressionist" bit of protoplasmic design, which may develop yet unattained virtues, if two racks and two pinions can be depended upon to wear uniformly when dividing a task between them. The work-table drives of other large milling machines will be noticed hereafter. The problem is important as well as extremely interesting.

MACHINE SHOP MILLING PRACTICE.—See page 1.

The very general conclusion that boiler explosions almost invariably come about from neglect, ought to go further than it does in the direction of preventing them. Public opinion has relegated the drift pin to disuse, and the question of material is pretty thoroughly settled in favor of the best. Neglect is the one thing that seems to trouble boilers to-day. It is discouraging to the conscientious boiler-maker to find his work destroyed for the want of cleaning and reasonable care; not only discouraging but damaging to his business. Failing to keep boilers clean, failure to have them properly inspected, and, above all, failure to put them in charge of competent men, are responsible for the great majority of boiler explosions. This last named cause is the most comprehensive because in the main it includes the others. Imagine the boilers of a transatlantic steamer in the sole charge of the firemen, and very similar conditions on a smaller scale can be found all over the country.

The Wurtemberg State railways are experimenting with petroleum engines.

The Van Norman Bench Lathe.

The accompanying engravings illustrate an improved bench lathe designed by Mr. Chas. E. Van Norman, of the Waltham Watch Tool Company, Springfield, Mass., which company builds the lathe.

The lathe is so arranged that, in addition to the ordinary work usually done upon such a lathe, it can readily be used for all kinds of milling, except spirals, which latter are not, however, much used or called for in the class of work for which the machine is intended. The lathe is made with bed 28″, 30″ or 32″ long, and will swing 7¼″ over the bed. Split chucks will take wire from smallest sizes to $\frac{20}{64}$, clear through spindle.

At Fig. 1 the lathe is shown in its plainest and simplest form, and, as will be seen, it is in essentials about as such lathes are usually made. Both head and foot-stocks clamp to the bed by cams.

The live spindle and bearings are of steel, hardened and ground, the main bearing being made with two tapers—5° and 45°. Split chucks of standard dimensions are used, and the larger flange of the cone pulley is drilled for an index pin.

Fig. 2 shows the lathe as arranged for screw-cutting, which is accomplished in the usual manner for lathes of this class. The rest here shown has a graduated swivel between the slides and hardened collars for the traverse screws; graduations for screws reading to .001″. The upper slide has a movement of 4″ and the lower one 5″.

The top of this slide is so arranged as to make it convenient for firmly attaching a vise or other fixture used for milling, as shown in Figs. 3 and 4 where the same rest is used.

At the end of the lathe a piece is cast onto the bed extending to the base of the pedestal as shown, to which it is also solidly cast. To the front face of this piece is fitted the knee shown, which has a vertical traverse of 4″, and can be securely clamped in any position by the capstan head screw shown at the back. The head-stock is reversed upon the bed for this work, the cone pulley on the countershaft being outside the bearings, and so arranged as to be readily reversed also.

The vise has also a swivel base graduated, jaws 3″ wide and opening 1.3″.

At Fig. 4 an index milling attachment is shown in place of the vise, this attachment being so arranged that the index spindle can be set at any desired angle in either the horizontal or vertical plane.

The same split chucks can be used in its spindle for holding work to be milled, and by means of the various adjustments, taper work, angular cutters, spur and bevel gears up to 6″ diameter are readily cut.

The lathe is also provided with a grinding attachment when desired, and, thus equipped, constitutes a very considerable machine-shop outfit within itself, and is especially valuable where tool and similar work of the finest grade is to be done.

Fig. 1.

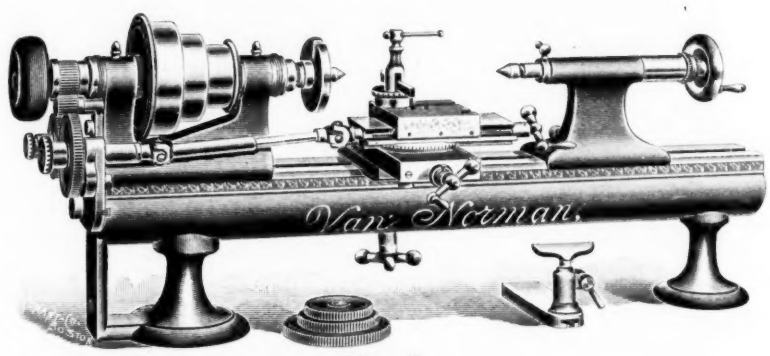


Fig. 2.

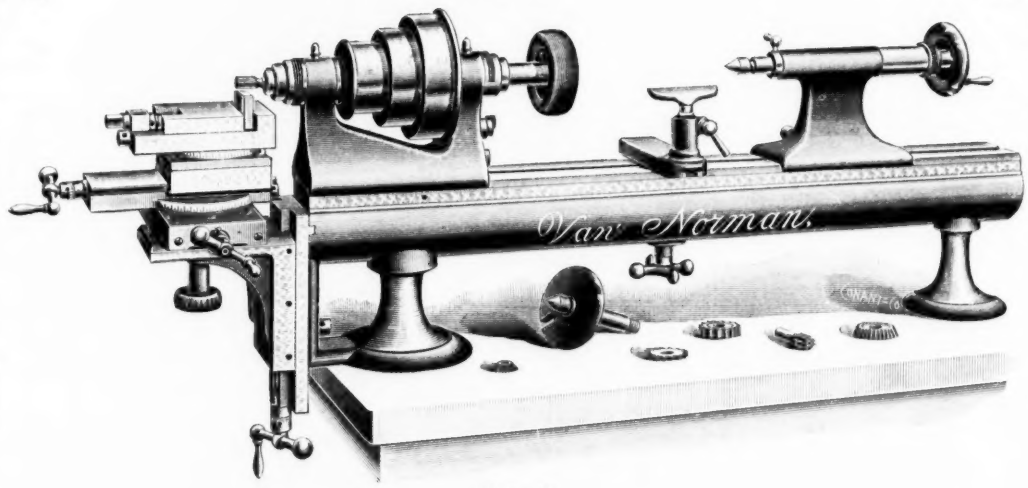


Fig. 3.

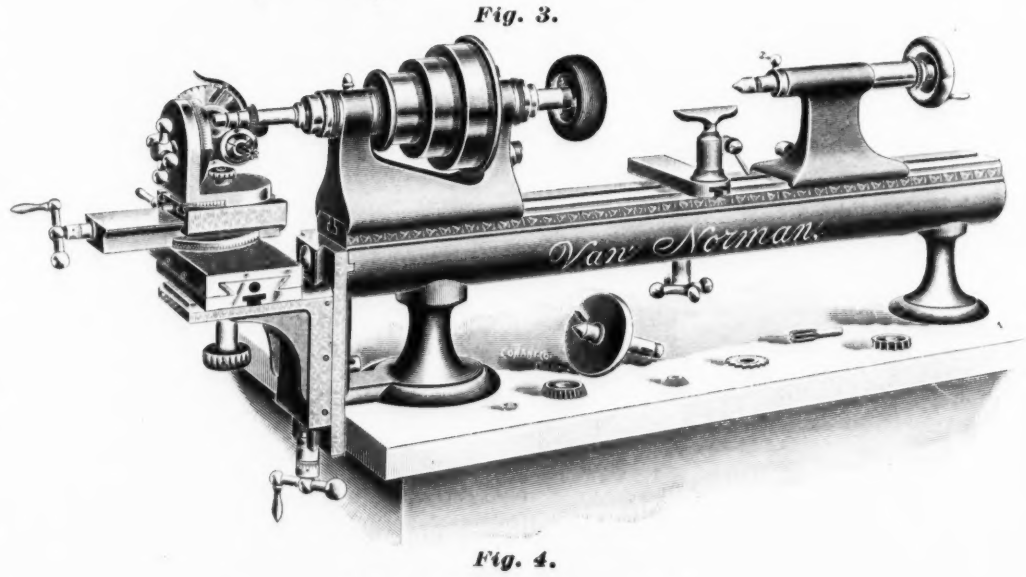


Fig. 4.

THE VAN NORMAN BENCH LATHE.

Safes and Vaults Built of Plates Cannot be Made Burglar proof.

BY BURGLAR.

CONCLUSIVE RESULTS OF A RECENT BANK ROBBERY.

According to general belief there has long been a controversy between the expert cracksman and the manufacturers of the ordinary square safes and vaults which are so widely used throughout the banking and safe deposit institutions of the world. In the progress of this so-called controversy the general idea has long existed that sometimes the square safe maker and sometimes the safe cracker has been victorious.

This idea has now become wholly exploded, because facts which have come to light show that the square safe maker has always been the under dog, and that at the present day he is so badly beaten that he cannot but admit the fact and be truthful. Why has the public been so long deceived in regard to the real facts? Because the safe maker has been able to make bankers and others believe that after every opening of a safe the construction is so changed by the manufacturers as to render the new safe absolutely impregnable. But actual recorded results show that just as soon as possible after this supposed invincible structure has been put out the expert cracksman comes along and proves its utter worthlessness, and this same operation has now been repeated so many times that it needs no argument in its support.

These square safes, as ordinarily built by the various manufacturers, are all alike so far as the principle of construction is concerned, and the variations that exist have no value as burglar-proof factors, but simply as giving the different makers the opportunity to have a name in the market. As every one knows, the constructions are built of iron and steel plates bolted together in various ways. The plates are from ⅛ to 1 inch in thickness, those of steel being hardened. The doors are built up in the same manner and differ only in form, some being square and some round.

It is not necessary to go into the details of the many ways that the burglar can operate and successfully open all these constructions. Three general methods are followed: First, drilling; second, tearing apart; third, blowing. The first method is perfectly practicable and easy. The second requires a few good cold chisels, wedges and a sledge. The third method now supersedes all others because of its celerity and certainty.

Now, the pith of this whole matter, so far as regards the supposed controversy between the square safe maker and the expert cracksman, is just here—the burglar has been working to develop that "kit" which will enable him to perform his work in the quickest manner. He has not cared what improvements were made in safes, because he has always known that he could successfully operate upon and open them. And the square safe maker has known this to be the fact, but has been powerless to prevent it.

From the somewhat lengthy operation of drilling or stripping the safe plate by plate, where a few hours' hard work was required, the cracksman now resorts almost entirely to blowing, and reduces the time to practically a few minutes. No construction built up of plates can be now made which will withstand the tearing and racking effect of the powerful explosive agents so widely known and used. The square safe maker is absolutely at the mercy of the cracksman who is dealing blow after blow without mercy, but with much profit to himself.

Does any one ask why the truth has not been generally known before? The plain answer is, because few have taken the trouble to investigate the matter carefully, accepting either a "say so," or a temptingly low price. When the subject is investigated, the truth has been profited by.

Within the past three months there have been four successful bank robberies in this country, netting the cracksmen $50,000. In each case the safe opened was of the ordinary construction, in each case all the money was taken, and in no case have the burglars been captured.

The most recent and important burglary will be referred to: The bank building is situated on the principal corner of the business portion of the town, virtually surrounded by other buildings, stores, hotel, etc.

Coming into town, presumably on a train arriving at 1.45 A. M., the burglars first broke open two blacksmith shops, and procured a few necessary implements—cold chisels, sledges and monkey-wrench. They then proceeded to the front door of the bank, and pried it open.

The bank vault is in the corner opposite the front door, and the burglars proceeded at once to open the iron doors. The combination knob of the outer vault door was pulled off with a powerful screw lever, and then the spindle and lock knocked off with a punch. The bolts were then thrown by the handle on the outside. The inner vault doors were opened by blowing the lock off with some explosive. Inside the vault the burglars found a safe of the following description: It measured outside about 3 feet high, 22 inches wide and 22 inches deep. The sides, top, bottom and back were 4 inches thick; the front and outer door were 4½ inches thick. It was built of 5-ply laminated steel plates throughout. The outer door was guarded by time and combination locks. Inside, at the bottom, was a so-called burglar chest, occupying about ⅔ of the interior. It was built throughout to a thickness of 3 inches of 5-ply laminated steel plates. Its door was guarded by a combination lock. The whole construction was built in 1889, and was warranted to be burglar-proof.

Slewing this safe around slightly, the burglars begun the operation of opening it with the tools, implements and explosives of their own particular kit. They selected the center of the upper edge of the door for the commencement. At this point they drove a small wedge to open the joint slightly. The entire joint between door and jamb was now covered with putty, except at the place where the wedge had been driven. Here a cup or well of putty was made, and into it liquid nitro-glycerine was poured, which ran into the safe and around the space between the door and jamb. A detonating cap was then applied at the point where the explosive ran in, and presumably some sort of cover was used over the safe to deaden the noise of explosion. The detonating cap was fired either with a time

fuse or electric battery, and set off the nitro-glycerine. As the result of the explosion, the outer door of the safe was torn out bodily, and blown against the wall of the vault, making a considerable indentation.

The plates of the door were torn apart, and badly frayed around the edge, and the bolt work and bolt frame on the inside completely stripped off, as were the combination and time locks. The plates of the jamb around the door were also frayed and forced apart by the explosion, and the upper jamb bowed up and broken through near the center. The door of the inner chest was now operated upon in a similar manner, and blown out and into several pieces by the explosion.

Nothing now remained for the burglars but to take the money and escape. A considerable quantity of this was torn by the last explosion, but the warranted burglar-proof safe had been opened so quickly, and so wide, that for all practical purposes it might just as well have been left unlocked. The burglars left behind them none of their own particular kit, but only the few implements stolen from the blacksmith shops. It is probable that they proceeded to take a train for Chicago, which leaves Franklin Grove at 3 45 A. M., so that the entire time they were in the town was two hours. Truly a quick piece of work.

The cashier of the bank arrived on the scene as usual on the following morning, and soon discovered that there was no necessity for opening up. Investigations commenced at once. They developed nothing that gave a clue to the robbers, but brought to light a very important fact, viz., a family slept in a room, which was separated from the back wall of the vault by a distance of only three feet, and no one of them heard any noise during the night, nor was any one else in the town aroused, though many slept in the near vicinity.

This operation is certainly the crowning success of the modern burglar, and no amount of explanation can do away with the main fact developed, viz., the square safe maker is finally forced into the corner of defeat, from which there is no turning, no escape.

One of the directors of the bank, who personally bought the safe, stated that it was the best square safe he could find, that it was warranted burglar-proof, and not being burglar-proof, nothing else in the State of Illinois is safe. The application of his statement extends throughout this country, and the world, and is summed up in a few words: The very best so-called burglar-proof square safe has been opened inside of two hours, and there is not one such safe in existence to-day that is any stronger. To go farther, they cannot be made burglar-proof. All of our safety deposit vaults are worthless, and every institution using such constructions is at the mercy of the expert cracksman, whenever the opportunity arrives for him to strike his blow.

Preliminary notice has been given that the spring meeting of the American Society of Mechanical Engineers will probably be held at Montreal, Can., June 4th.

The Cochrane Feed-water Heaters and Purifiers.

The outline engravings presented herewith show the construction of different forms of the Cochrane feed water heaters, purifiers, etc., as recently improved and now made at the Harrison Safety Boiler Works, Germantown Junction, Philadelphia. In all these various forms of heaters, the condensed exhaust is utilized, it being previously cleared of oil by a separato drip from separator and the overflow, also interior water seal for the water supply pipe.

Fig. 2 shows the arrangement of the feed-water heaters and purifiers, which are of the same general design as the feed-water heater, but of larger storage and settling capacity, with larger tray surfaces, and provided with a lower shelf for holding coke, hay or other material to give additional depositing surface, and with suitable openings for handling such material.

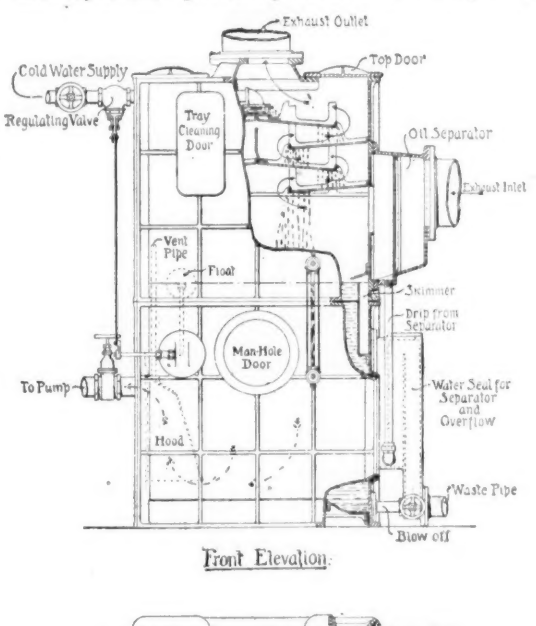


Fig. 1.

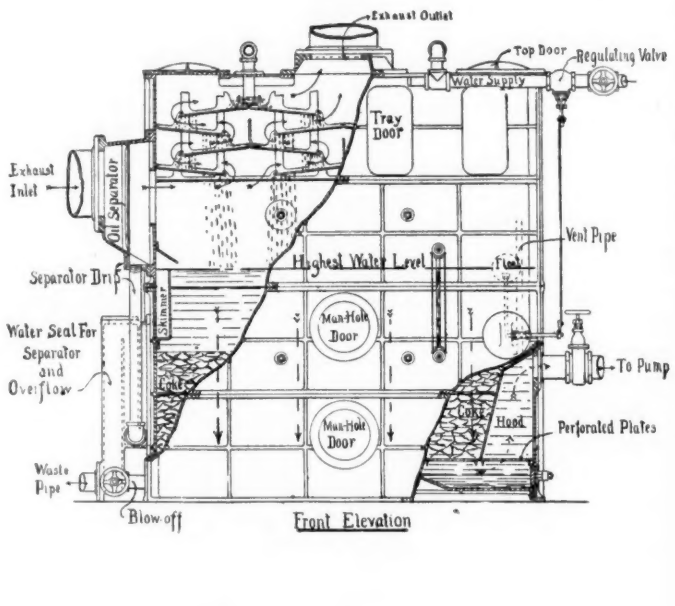


Fig. 2.

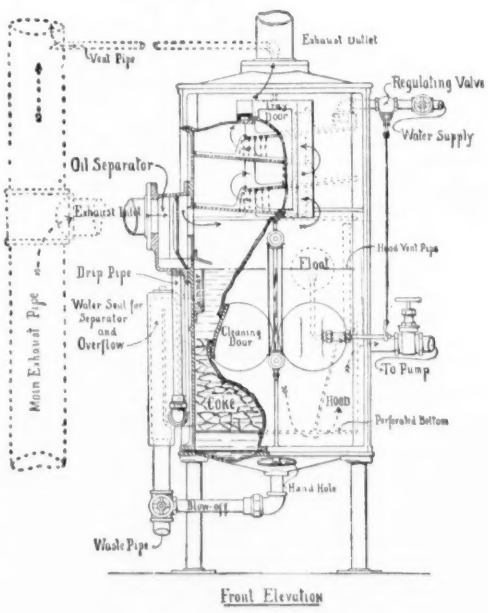


Fig. 3.

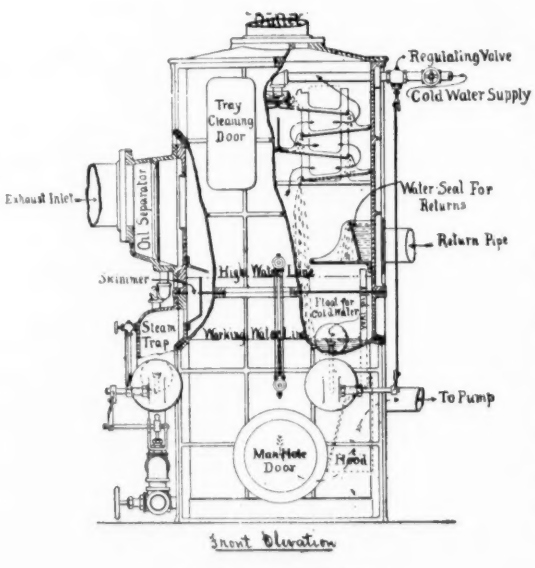


Fig. 4.

THE COCHRANE FEED-WATER HEATERS AND PURIFIERS.

which forms part of the heater. There are no tubes, and yet the water is purified so far as possible at the heat to which it is raised.

Fig. 1 illustrates the construction details of the feed-water heaters; which, built of cast metal, are equipped with an efficient oil and grease separator, trays for subdividing the incoming cold water, float with lever connection to balanced regulating valve controlling the water supply, overflow, skimmer, hood, and water seals for the

Fig. 3 shows how either the heaters used for heating only, or feed-water heaters and purifiers may be connected to the exhaust. One way is to pass all of the exhaust through the heater. The other is to draw from the main line, venting back by a small pipe to this line, which prevents air lodging, and provides for the escape of the liberated gases.

The Cochrane special feed-water heaters and receivers, adapted for heating systems using exhaust steam, are constructed on the plan shown by Fig. 4. These heaters are built for pressure, though they can be operated as open heaters when the heating system is not in use. Briefly, the system is as follows:

The different exhausts from pumps, engines, etc., are collected in one pipe, and passed into the heater through the separator which extracts all oil or grease. The boiler feed water is first taken care of—the cold water needed to supplement the returns absorbing the required amount of exhaust steam. The surplus exhaust then passes through the heating system, and this, when condensed, is gathered and brought back into the heater in the form of hot water, the exhaust being supplemented when necessary by live steam direct from boiler passing through a reducing valve, which is so set that it will admit steam only when the pressure of the exhaust falls.

The exhaust pipe to atmosphere is provided with a back pressure valve set to any required pressure, usually less than 5 pounds. The regulation of the cold water supply by the float insures the saving and use of all the condensed water returned from heating system, before fresh water is permitted to enter. The capacity of the heater, and the regulation of the float, permit the storage of a certain amount of the return water.

While going to press with our last issue, No. 93, the first of the new type of torpedo boats ordered in 1892, designed by Mr. W. H. White, C. B., Director of Naval Construction, and built and engined by Messrs. Jno. I. Thornycroft & Co, of Chiswick, was completing her trials off Sheerness, at which the usual Admiralty officials attended. The runs on the mile were made on the 14th inst., and gave the following mean results: With steam at 225 pounds pressure per square inch the engines made 472 revolutions per minute, giving the ship a speed of 23.85 knots. On the three hours' continuous run on the 21st inst. 467 revolutions per minute were made by the engines, and the speed of ship by log was 23.5 knots. The new type torpedo boats are 140 feet long, 15 feet 6 inches beam, and their loaded draught 5 feet 4 inches. No. 93 is the only one ordered to be fitted with twin screws. She has three cylinder triple expansion engines of 2,000 horse-power, supplied with steam by two Thornycroft water-tube boilers. The vessel is armed with three 3-pounder guns, and fitted with three 18 inch torpedo tubes.—*The Engineer* (London).

We receive a good many inquiries as to the evaporative efficiency of oil. In our issue of January 25th, we made note of a Bradley burner in use at Bayonne, N. J., since then we have seen a letter from the engineer, Mr. Geo. O. Hodgson, in which he gives as the result of a test the evaporation of 17.34 pounds of water per pound of oil, the boiler working beyond its rated capacity. The boiler is 5 feet diameter, 16 feet long, with 80 3 inch tubes.

Stranger—"What a cheerless, dreary, depressing looking building that is." Native—"Oh, that's only a school. Do you like fine architecture?" Stranger—"I do." Native—"Then wait till you see our new jail."—*Good News.*

Graphical Solution of Cubic Equations.

BY GEORGE B. GRANT.

The solution or finding of the roots of a cubic equation is a frequent operation in practical mathematics, and at its best it is a blind and tedious process. Treatises on algebra have a confusion of rules and theorems which many have studied, few have understood, and still fewer can apply to practical cases; and, while we have Cardan's complicated process when only one of the roots is real, and the auxiliary trigonometrical method when the roots are all real, the best reliance is still the cut and try method of substitution. We must substitute numbers at random for the variable until we happen to find but a small error, and can then work the result out as closely as we please by approximation. The following graphical method may be novel, and it is certainly useful. It will give all the roots of any cubic equation to an approximation of within about a hundredth of an inch of the truth.

Draw a cubic parabola, C^1 O C, Fig. 1, for which the distance A B is always equal to the cube of the distance O A, and which can be quickly drawn in by points with the aid of a common table of cubes. If there is much work to be done this curve should be drawn in ink, on bristol board, and then the operation of finding any root can be performed in pencil and erased.

Now, take any cubic equation

$$x^3 + a\,x^2 + b\,x + c = 0,$$

and compute the three distances

$$O\ P = \frac{a}{3},$$

$$O\ M = \frac{a\,b}{3} - c - \frac{2\,a^3}{27},$$

$$M\ S = \frac{a^2}{3} - b.$$

As in Fig. 1, lay off the distance O P, and draw a line through P parallel to the axis Y Y. Lay off the distance O M, then the distance M S, all three as computed; then lay off S T equal to unity, and draw the line M T.

When, as in the case chosen for illustration, there are three roots, this line M T will cut the parabola at three points, X_1, X_2 and X_3, and the required three roots are the distances P_1 X_1, P_2 X_2, and P_3 X_3.

When, as illustrated by Fig. 2, there is but one real root, the line will cut the curve at but one point, and the distance P_1 X_1 is the root.

Sometimes there is a pair of equal roots and in such cases the line m t will touch the curve at the point x_1 x_2, Fig. 2, and cut it at x_3. Mathematically considered, a point of tangency is a double point, so that there are two roots coinciding in the distance x_1 x_3 p_1 p_2. The distance x_3 p_3 is the third root.

When we meet with the case of three equal roots the line M T will coincide with the axis X X, and the three roots will coincide in the distance O P, for the point of inflexion at O is a triple point.

To save the trouble of drawing the second branch O C^1 of the curve, lay off O M^1 equal to O M and O $P^1 = O$ P and draw the broken line M^1 T^1 parallel to the line M T. The distance X_4 P_4 will be the same as the third root X_3 P_3, as illustrated by Fig. 1.

As an example take the equation

$$x^3 + 1.65\,x^2 - .3094\,x - .2352 = 0,$$

and compute the distances O $P = +.55$, O $M = -.26$, and M $S = +1.21$, and lay them off as shown of full size by Fig. 1. The three roots are P_1 $X_1 = +.41$, P_2 $X_2 = -.32$, and P_3 $X_3 = -1.77$, the true roots being $+.42$, $-.32$, and -1.75.

Another example, illustrated by Fig. 2, is the equation $x^3 - 2\,x^2 + 2\,x - 1 = 0$, for which O $P = -.67$, O $M = +.26$, and M $S = -.67$, the single root P_1 X_1 measuring $+.99$, while its true value is $+1$.

Even when the roots are required with greater accuracy this method is of great assistance to fix the first approximation.

When it happens that the second term of the equation is absent, the equation being $x^3 + b\,x + c = 0$, we have the computation greatly simplified, for then $a = 0$, and O $P = 0$, while O $M = -c$ and M $S = -b$. Any complete equation can be transformed into this form by substituting $x = x - \frac{a}{3}$ but it is quite as easy to compute the distances as directed.

The same rule and curve can be used for solving any equation of the second degree, but as the ordinary process is very simple there is no occasion for its use. Given the equation $x^2 - .5\,x - .5 = 0$ we multiply it by x and get the cubic equation $x^3 - .5\,x^2$

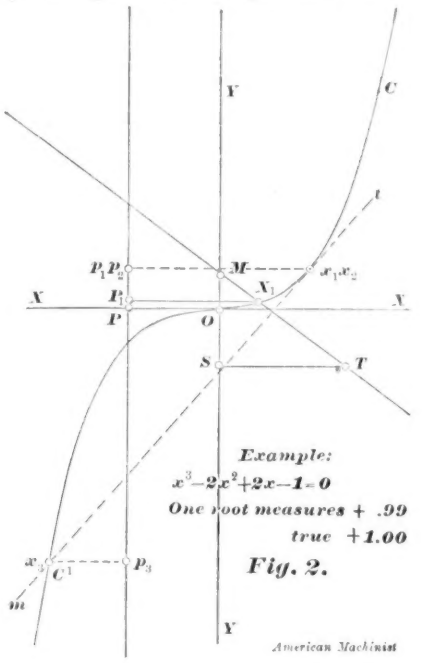


Fig. 2.

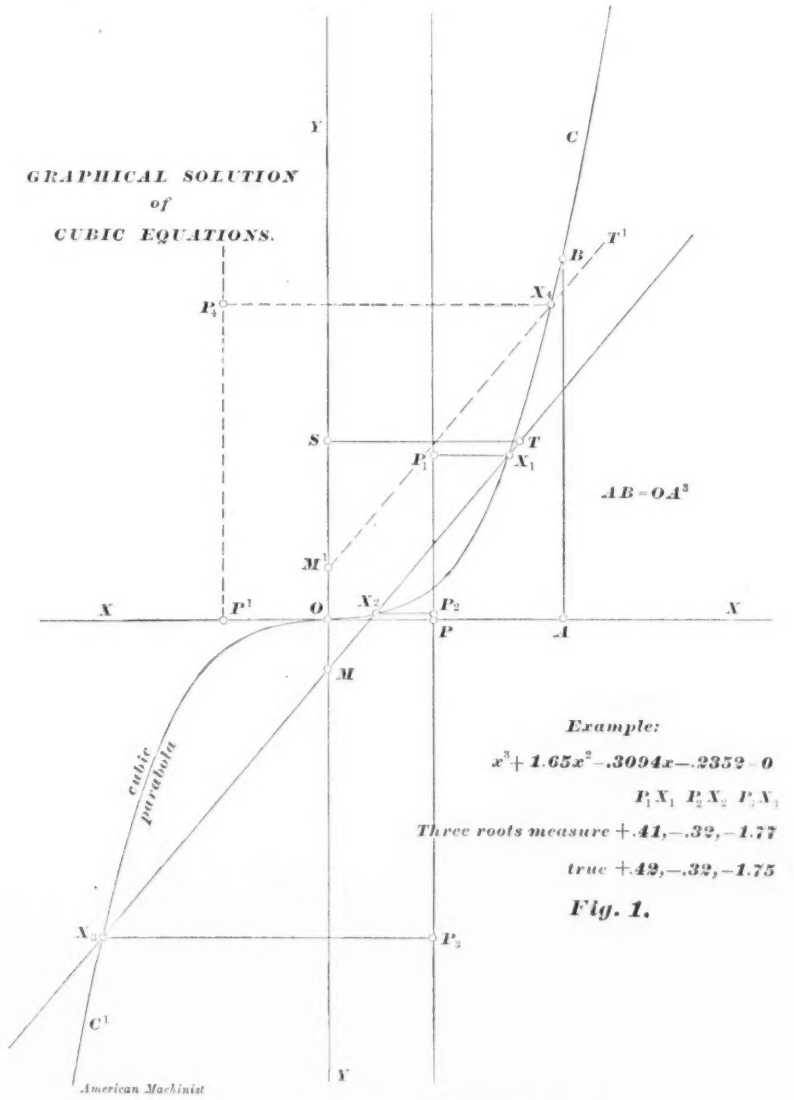


Fig. 1.

GRAPHICAL SOLUTION OF CUBIC EQUATIONS.

$-.5\,x + 0 = 0$, from which O $P = -.17$, O $M = +.09$ and M $S = +.58$, and then drawing the line as directed it intersects the curve and gives the three roots $x = 0$, $x = -.5$, and $x = +1$.

A correspondent of *Engineering* argues that for forced blast under fire bars the jet is not worth considering in comparison with a Sturtevant or Roots blower. He says Sir William Siemens used forced draft under fire bars 21 years ago, and after careful experiments found the annular nozzle the best arrangement of jet.

LETTERS FROM PRACTICAL MEN.

Computing Change Gears.

Editor American Machinist:

Referring to the change-gear discussion, if the ratio of the threads of the lead screw 8, and the threads of the screws to be cut 14, be written in the fractional form $\frac{8}{14}$ and reduced to its lowest terms $\frac{4}{7}$, there are no fractional multipliers, and *all* of the combinations that will cut the thread are obtained by multiplying both terms of the fraction by integers 4, 5, 6, etc., as below:

	4	5	6	7	8	
$\frac{4}{7}$ =	$\frac{16}{28}$ =	$\frac{20}{35}$ =	$\frac{24}{42}$ =	$\frac{28}{49}$ =	$\frac{32}{56}$ =	
9	10	11	12	13	14	
$\frac{36}{63}$ =	$\frac{40}{70}$ =	$\frac{44}{77}$ =	$\frac{48}{84}$ =	$\frac{52}{91}$ =	$\frac{56}{98}$	, etc.

EXPERT.

Strength of Beams.

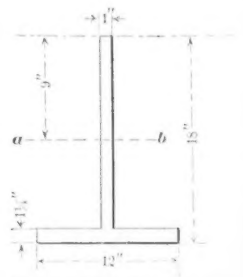
Editor American Machinist:

In an article on the "Strength of Beams," in the AMERICAN MACHINIST, January 4, 1894, Mr. Mackintosh attempts to show that Prof. Mansfield Merriman, and consequently with him such men as R. H. Thurston, Gustave Lange, Weisbach, etc., err in the absolute proof they and all sufficient authorities give that the neutral axis of all beams of whatever material passes through the center of gravity of the section. It is to be regretted that Mr. Mackintosh's error has not been pointed out. In the article referred to, the stresses induced in the fibers of the cross-section are confused with the ability of those fibers to withstand the stresses when pressed beyond the elastic limit to the ultimate strength of the material. The compressive strength of a material might be a million times as great as the tensile strength, but that would not affect one iota the strains produced in any fibers by any stress within the elastic limit, and it is only within the elastic limit of materials that the formulæ for the strength of beams obtain. A fundamental law is that the horizontal stresses in a strained section are proportional to their distances from the neutral axis, provided the elastic limit of the material be not exceeded. Then, from Merriman's "Mechanics of Materials," edition of 1885, page 39, if

S = unit stress on fibers most remote from neutral surface at distance c, $\frac{S}{c}$ = unit stress at distance unity.

$\frac{S}{c}\,z$ = unit stress at distance z, and

$\frac{S}{c}\,a\,z$ = total stress on any fiber of area a, and the sum of all these total stresses, such as $\frac{S}{c}\,a\,z$ or $\Sigma\,\frac{S\,a\,z}{c}$ equals the algebraic sum of all horizontal stresses, and since the beam is in equilibrium, $\Sigma\,\frac{S}{c}\,a\,z =$



0. S and c being constants $\Sigma\,a\,z = 0$, which it is shown in elementary mechanics is true only when z is the distance to a line passing through the center of gravity of the section.

S is the actual unit stress produced, and primarily has nothing whatever to do with the compressive or tensile strength of the fiber. But having made certain the correctness of the formula, known values for this unit stress S can be assumed for different materials safely within the elastic limit, and the proportions designed so that this safe limit is never exceeded. Take Professor Merriman's beam of cast iron. According to Mr. Mackintosh, the neutral axis passes through $a\,b$ 9 inches each way from the remotest fiber. Since he takes the formula $W = 8\,\frac{S\,I}{l\,c}$ to be true, he must agree that the stresses are proportional to the distances of the fibers from the neutral axis, for this equation depends directly upon that fact. Then if there is a unit stress of S pounds along the upper layer most remote from the assumed neutral axis, a like unit stress occurs in the lower layer 12″ long. And Mr. Mackintosh can keep on adding layers to top and bottom until the section is complete. But if the assumed neutral axis were correct, the sum of the stresses in the lower layers from $7\frac{3}{4}$″ to 9″ from the assumed neutral axis would be twelve times as great as the sum of the stresses in upper layers from $7\frac{3}{4}$″ to 9″ from the assumed neutral axis, and these layers would not be in equilibrium while the remaining layers would be in equilibrium, which is obviously contrary to any possible case.

Mr. Mackintosh should confine himself to the formulæ given by such good authority as Professor Merriman. If he had occasion to design a cast-iron beam, and assumed the neutral axis midway between the top and bottom of the section, the beam would be unsafe, as is his supposed beam on which he puts a uniformly distributed load of 3,360 pounds, when all good authorities would limit the safe load to 2,667 pounds. Again, Mr. Mackintosh's method would make Professor Merriman's beam good for 19,285 pounds, distributed for compression, and 21,326 pounds for tension, though it is to be inferred from Mr. Mackintosh's article that he would add these and get a safe load of 40,611 pounds, whereas the safe load is but 30,400 pounds. GEO. T. SNYDER.

Editor American Machinist:

In your issue of January 18th, Mr. F. Garside criticises my article on the "Strength of Beams." His first paragraph I shall have to pass over lightly as he does not make clear its application. I would say, however, that I used the formula for the same purpose, with the same material, and the same assumed properties, as did Professor Merriman in the example I cited.

Mr. Garside's second paragraph is almost as vague as the first. He makes the unsupported statement, that to argue from in-

finitely thin flanges to flanges of finite thickness, is an error. Also, that to leave out the flange alters the character of the beam. He finishes the paragraph, however, by admitting, in effect, that the latter statement is without value and does affect the application of the formula. This being the case he might have saved words.

In the third paragraph he pretends to use the formula he is defending, but he locates the neutral axis away from the center of gravity, thus doing the one thing for which I contended. It is true he tells us that the center of gravity is at 4.5″ and 1″ respectively from top and bottom. This, however, is not the case, for the two flanges being of equal breadth and equal area, the center of gravity is of necessity midway between them.

That he is still further in error must be evident when it is considered that the flanges of Hodgkinson beams have to be proportioned very differently from his to give equal strength.

The remainder of his letter is principally an argument over *terms*, as applied to beams and open girders, but they are of no moment in the case under discussion as the formula and its accepted application are the same for an I beam as for a latticed girder, and the latter is simply a beam without a web.

Now, if Mr. Garside wishes to make further reply, I would remind him that the first thing to do in argument is to show the fallacy of an opponent's reasoning. This should be done before new arguments are presented. Bearing this in mind, let him consider my original article and disprove the following deductions from the same:

1. That Professor Merriman used the formula for finding the safe working strength of a cast-iron beam.

2. That I used it in the same way, and for the same purpose in obtaining a result that I claimed to be wrong.

3. That a correct formula will apply to latticed girders with flanges of any thickness, infinitely thin or otherwise.

4. That in an open beam (latticed girder) the reactions of the two flanges against each other are equal.

5. That Professor Merriman's assumed strength of cast-iron, with his assumed factor of safety, gives equal safe working strength to my two flanges, each composed of a single layer of fibers.

6. That 4 and 5 being correct, the neutral axis must be at a point which will give equal moments for each flange.

7. That such neutral axis will not be at the center of gravity.

If my reasoning is correct for infinitely thin flanges, and the neutral axis is where I have located it, its position would not be sensibly changed if the flanges were increased to a small finite thickness, say .01″, or even .1″. I will admit, however, that for each addition to the thickness of the flanges the position of the neutral axis would change slightly, and its final location would not be where I previously placed it. It would at no time, however, be at the center of gravity, and *this is the one point at which all my argument is aimed.*

If Mr. Garside will refer to Unwin's "Elements of Machine Design," eleventh edition, paragraph 32, he will find my proportions of flanges, for equal strength, pretty well confirmed.

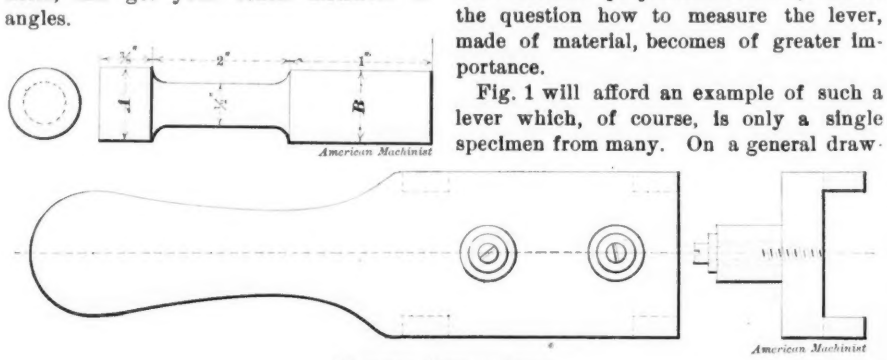
E. D. MACKINTOSH.

Making Drill Jigs—Limit Gauges.

Editor American Machinist:

In your issue of January 25th is a very interesting article, by Barton Cruikshank, entitled, "Device for Drill Jigs." Allow me to try and show another simple method, which, perhaps, will be of some help in making correct drill jigs. The following rough sketch will explain how to do it: Please note that the steel bush fits the body of the screw $\frac{1}{16}$″ loose, thus allowing the toolmaker to rap or adjust the bushing to its desired position. When the bushings are placed correctly, I would advise strapping the jig to the face-plate of the lathe; then adjust it so the bush will run true. An outside indicator should be used to enable the workman to know that the bush is true. After this is done, remove the screw, and proceed to *bore the hole* to any desired size. This kind of work should be done on a lathe that has a *round spindle*, and that bores and squares straight. Several holes can be bored in a jig with this method to within .0005″. I doubt very much if this degree of accuracy could be obtained by using "drills and counterbores."

I would advise to always test the jig before fitting in the hardened drill bushings. A good way is to turn plugs to fit the bored holes, and get your center distances or angles.



MAKING DRILL JIGS.

I am making for our shop a set of standard internal cylindrical limit gauges from $\frac{1}{4}$″ to 3″ diameter, varying by sixteenths of an inch. The style of these limit gauges will be best understood by the second sketch, end *B* go in, end *A* not go in. Now, the question that arises is, how much under to make *B*, and how much over standard to make *A*? The work to be tested with these limit gauges is such pieces as are used on first-class machinery, where interchangeability is an essential feature. I have about decided to make *B* .0005″ under, and *A* .0015″ over. We believe the time has come when we all should work to the same standard for the same class of work, and, perhaps, through your valuable paper, some of your practical readers will give us a little information on this question.

J. A. MCGREGOR.

Errors on Drawings.

Editor American Machinist:

Many volumes have been written showing "how to make drawings," but it seems to me that an important part of "how to make drawings" has been neglected. It is not my intention to show new ways of projecting points, lines and surfaces, but it is to speak about the finishing of drawings, especially of giving the dimensions and such other things relating to them which are of practical value. To many draftsmen all this may be nothing new, but to the novice at the drawing board, I am confident, it will be of value, because often things are demanded which he does not realize, and which he only will acquire by experience in the long run of hard work and much annoyance.

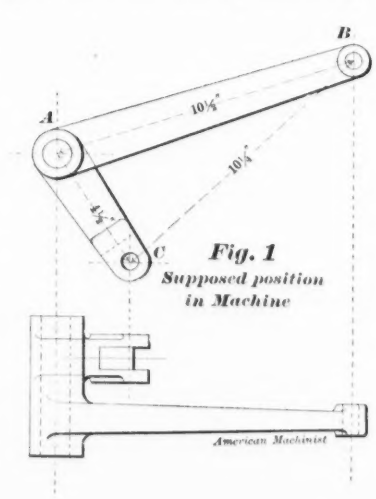


Fig. 1
Supposed position in Machine

In designing machinery certain parts will receive peculiar outlines, and their dimensions are readily ascertained from the general drawing, especially fundamental ones, such as distances from the centers of fulcrum and rollers of levers and dimensions of other parts which, by virtue of their own, have certain characteristics, all of which may be easily stated in feet and inches and fractions thereof, or degrees and minutes, etc., on general drawings, but all of them may be far from being convenient for working purposes.

If, for instance, the three points of a bend lever are located in one plane there would arise no difficulty in constructing the triangle by simply stating the length of each side; however, it will occur quite frequently that a plane cannot be passed through the three points, that is to say, that the lever will have projections or hubs, whence the question how to measure the lever, made of material, becomes of greater importance.

Fig. 1 will afford an example of such a lever which, of course, is only a single specimen from many. On a general drawing it may satisfy to state that the distances from *A* to *B*, *B* to *C* and *A* to *C* are $10\frac{1}{2}$, $10\frac{1}{4}$ and $4\frac{1}{2}$ inches respectively, and, further, it may be of importance for the draftsman to know that these are the correct dimensions, but to have a working drawing with such statements pass to the workshop is equally costly to the manufacturer and embarrassing to the workman, because he will have to use inconvenient contrivances in order to lay off the required distances. To expect from a workingman to help himself, especially to convert figures into other values, obtainable by the laws of trigonometry, is simply ridiculous, because he generally is not, nor is he expected to be, a mathematician. It is an easy matter for a draftsman to so place the lever on his drawing that either the horizontal or vertical axis may pass through any two points of the lever, respectively, and then state the proper dimensions according to rectilinear co ordinates, and a lot of time and trouble is saved all around.

A drawing prepared with these points in view will at once suggest how to place the lever upon the surface plate and lay off the distance given by means of a square and surface gauge. In the first case mentioned, if an attempt were made to lay off the distances with the aid of a pair of compasses, a difficulty would present itself which would increase with the increase of the magnitudes of the lever, while in the second case this objection is eliminated at once.

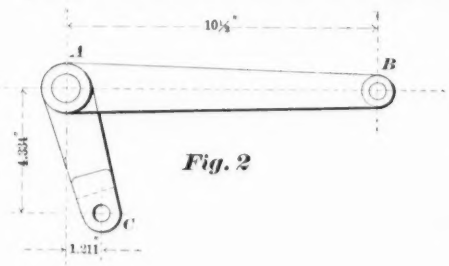


Fig. 2

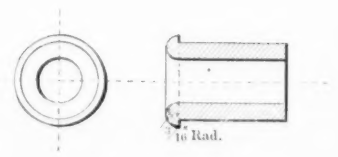


Fig. 3

ERRORS ON DRAWINGS.

The difficulties spoken of before have occurred to me quite frequently, and the more so, as it also has taken a considerable amount of time to caution draftsmen with whom I had occasion to work against these errors of statement; it therefore is not theory that I am preaching, but common every-day practice. Fig. 2 will explain, if language is incapable, how a drawing of a lever should be made. Here the horizontal axis has been made to pass through the two points *A* and *B* of the lever, suggesting to so place it on the surface plate that a line drawn through them be parallel to the plate, the dimensions laid off on the plate, and then projected by means of a square, while the vertical distances are easily fixed with a surface gauge. Another error is very often made on drawings of jigs.

A drawing of a jig, in many cases, is original work of the draftsman, and it seems that he will go to work with particular zeal to make his drawings as complete as possible, in the meantime disregarding important facts, while detailing the minutest parts to the extreme. As all mechanics know, jigs are not made to rigid rules which do not differ in any respect, but are subject to the conditions of the particular case, the main object being to produce the accurate parts quickly and cheaply. Upon the accuracy demanded depends the construction of the tool, and not upon the drawing, showing the radius of the rounding off of bushes. See Fig. 3. Bushings are only rounded off to prevent the drill losing its cutting edge and have it enter the bushing easily. Only reflect for a minute how expensive a single bushing is when made to such a drawing, and this unnecessary expense is multiplied by the number of bushes. It is true it will pay to spend time and care when making a jig, but it never will pay to spend it in the sense mentioned. The accuracy of a jig is independent of the radius of the rounding off of bushes, or the radius of rounding off the edges of the general casting, or even the diameters of bosses, if they have no other functions to perform than to hold bushings, but it solely depends upon correct figures and the careful execution by the tool-maker or machinist. Leave off from your drawings all unnecessary figures, make them as plain as possible, take special care that if you were requested to work from them, you could do so by simply reading.

The greatest errors on drawings are incorrect figures which draftsmen especially should avoid; of course, it is much easier said "to avoid" than to show a means which will unerringly detect such figures. Another source of great annoyance are figures which might be taken for anything we please. I have a drawing within my reach on which the dimension $1\frac{1}{8}$ is meant, but this very dimension ($1\frac{1}{8}$) has been read as $1\frac{1}{2}$. $1\frac{1}{8}$ and $1\frac{1}{4}$. Such errors as these are not with the men who read them, but with the draftsmen who state them so on drawings. The only reasons for this state of affairs can be accounted for in two ways, viz: (1st) Carelessness, and (2d) a desire to do fancy work. In the first case, if a man is careless, he is not fit to hold any position of responsibility, much less that of a draftsman; in the second case mentioned we must consider that drawings are not made to be framed and put on exhibition where they might be admired for their phantastic curves and scroll work in general, but that working men are to handle them whose guide they shall be while producing useful work. Make your drawings plain, the figures upon them distinct and legible, so that they can be read at a distance of 2 feet from the eyes; particularly avoid writing a whole number in the same line of the numerator of a fraction ($1^1/_{16}$), but be sure that the division line of the fraction be midways of the whole figure and to cover the denominator entirely, thus ($1\frac{1}{16}$). Remember, it never will do to "slap them down," an expression I have heard at times. Occasionally we, of course, cannot do as we please, being subject to the dictation of others. When this is the case it might happen that you are favored with easy solutions of geometrical problems, such as involutes, ellipses, etc. By the way, speaking of ellipses I will state one solution given to me—here it is: If one of two equal circles be connected by a link to the other and revolved about it, then any point of the revolving circle will describe an ellipse! I presume *the link*, connecting the two circles, has the power to render a cycloidal curve into an ellipse.

E. LAWRENZ.

Belting.

Editor American Machinist:

I note in the last AMERICAN MACHINIST your comments on Mr. Taylor's paper on belting, read before the last meeting of the American Society of Mechanical Engineers. I refrained from offering any criticism of the paper at the time, although his conclusions differed very widely from mine, which I have long since published, and which are the result of 50 years' experience with belts, instead of 9. Mr. Taylor's standpoint is, however, different from mine, as he deals exclusively with "shipping" or shifting belts, while my rules relate to those which run steadily in one condition or position, and I usually add 50 per cent. to my width, if the belt is to be constantly shifted, to meet the strain of the *vis inertia* when starting the machine.

In one point I think Mr. Taylor is in error. For a tension of 71 pounds on the belt, he allows 50 per cent. or 36 pounds on the pulley. My experiments show that the frictional strain on the pulley is about equal to the initial strain on the belt, or 50 per cent. of the double pull on both sides of the pulley. (See paper read before the Hartford meeting of the American Society of Mechanical Engineers.)

Many of the large cotton-mills in New England have followed my rules, and found them ample, and I found an illustration of what a belt *would do* a few days since, which beats all my rules.

Some six years ago I was called down to Maine to weigh the power of a mill which had been growing, until it had overloaded the wheels. I found it to be 470 horse-power, driven by four small wheels, which had been added from time to time, and I advised the agent of the mill to take them out and put in two larger ones which would give 500 horse-power. This was done, but a few weeks since I was sent for again to reweigh the mill. New machinery had been added, and the old "speeded up," until on the new weighing it took 556 horse-power, and there was about 32 horse power of machinery standing idle.

Now, when I first weighed the mill, I examined the main belt, which I found to be 30 inches wide, $\frac{5}{8}$ inch thick, and running at a velocity of 3,900 per minute on to a pulley 5 feet diameter. I then pronounced the belt to be fully loaded, but it was running so quietly and easily that I thought it safe to go on.

On my last visit, January 3d, I found the same belt still running apparently as well as ever, and carrying the increased load, which during six years had been added to it. This gives a velocity of 210 feet per minute, at which each inch in width of belt transmits a horse-power, and has been doing so safely for some years. I told the agent of the mill that he had better add a foot in width to his belt for safety, if he wanted to start the other machinery, and put in another wheel. There the matter stands; it shows that "circumstances alter cases," and that even nine years' experience in one shop is not sufficient to formulate general rules on.

SAMUEL WEBBER.

Cutting a Multiple Thread Screw.

Editor American Machinist:

Some time ago there appeared in your valuable journal a few articles on "Screw-cutting," by C. W. Wright, but as he has not touched a case parallel to one I had to do with, it may not be amiss to give the benefit of it to the AMERICAN MACHINIST'S readers.

It was required to make a hob of six multiple worm threads, *R H*, with a 3″ lead, $6\frac{39}{64}$ diameter. The tool available was a 20″ lathe of a good make. It was at once impossible to cut so uncommon a thread with the ordinary devices for screw-cutting, so this is the way we did it: From castings we made *A A* and *B B* of Figs. 1 and 2. *B* is [illegible] fitted to screw on lathe spindle; its circumference is divided into six equal parts and drilled and taper reamed, for the reception of a stop pin *b*. *A A* is a clamp or strap fitted nicely, and is slipped onto and shoulders against *B* at *a' a*. The drivers *E E* are bolted and doweled onto *A A*, as shown at *f f*, Fig. 2; the dowel pins serve to get the drivers back exactly in their places, when it is necessary to cut other than six threads. As will be seen in Fig. 2 the drivers act as a guide to keep the holes in line with stop pin, they working easy over the face of *B B*.

A A is now fitted with the stop pin *b*, whose sleeve is screwed to its seat at *e*; *b* is held in place by the spring *c*. By slacking up bolt *D*, and disengaging stop pin *b*, the strap *A A* may be moved around until the pin again engages, when the bolt *D* must be tightened; thus proceed until the required threads are produced. This same head, as may be readily seen, can be used to cut multiple threads of 2, 3, 6, or 12 by drilling more holes in *A A*, and should a thread be required not included here, fit an extra piece *A A* to the lathe spindle, and drill the required number of holes in it. When cutting these threads I have found it good practice to go round the threads several times before getting full depth of thread, so that if error has crept in by the moving of tool, it would show when the starting point is reached again, and may be remedied if not too great. This furnished us a very acceptable dividing head, with which the writer was enabled to cut a 6 multiple thread $4\frac{3}{4}$″ diameter, 12″ long, depth of tooth, .0330″, in less than four hours, going over the entire screw four times. Now, to cut the hob (after we had a dividing head) best, for it had to be as accurate as possible, was the next thing to do, so to avoid making more than one new gear, or a new lead screw, this is what we did: At the end of head-stock we bolted Fig. 3, being a sleeve or bearing, *H H*, to admit a spindle running parallel to main spindle; upon this auxiliary spindle were keyed the necessary change gears for driving, the gear *F* being the new one, and engaging with the gear on the cone of the lathe, thus transmitting the power to the screw through a train of four gears. We were a little afraid, if we had trouble at all, it would come from the rather long gear train, but we were pleased to get a very rigid and satisfactory job from the device. For this hob we were obliged to make a special arbor for a milling machine heavy enough to be provided with arbors that would carry this hob.

HARRY M.

Fig. 1.

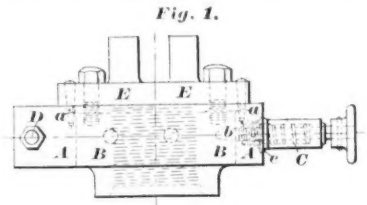
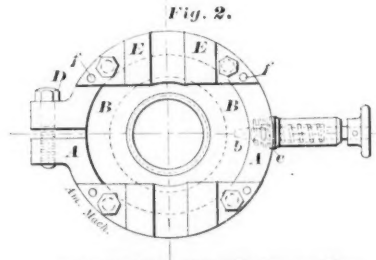


Fig. 2.



DIVIDING HEAD for cutting MULTIPLE THREADS. Scale, 1-6 Size.

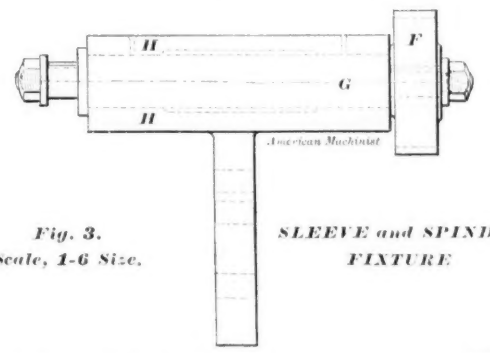


Fig. 3. Scale, 1-6 Size.

SLEEVE and SPINDLE FIXTURE

CUTTING A MULTIPLE THREAD SCREW.

The Fire at Purdue University.

Editor American Machinist:

Referring to the account given in your issue of February 8th of the disastrous fire at Purdue University, I am moved to express briefly my most sincere hope that it was not in any degree due to an unwillingness or failure on the part of any one, either the architect, the trustees, or some one who may have furnished means for the enterprise, to conform in the strictest sense to the principles which experience has so conclusively shown must be acted upon if only an approximate degree of safety is to be obtained.

I know nothing of the construction of the buildings, one or more, which have been destroyed, but the manufacturing world has been able to show for years past, in well-approved use, by far too many buildings such as these might have been, to warrant the use for such purposes of anything, either in design or construction, that could by any possibility be thus wiped out of existence at a moment's notice and apparently without any hope of remedy.

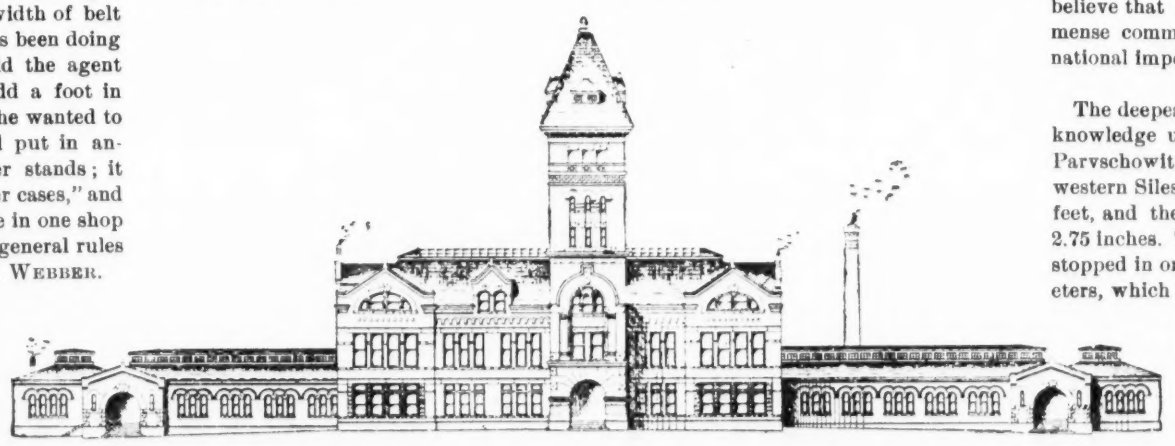
In some cases it has been insisted upon that buildings for this kind of service should have a certain degree of so-called architectural elegance, but, as such things go in this part of the world, this has come to be too often only another name for complicated framing and imperfectly resisting material, a combination which leaves little room for any hope of saving it in an emergency. For a service of the kind required at Purdue it would certainly seem as though the massive and slow-burning "timber-and-plank" construction would be the thing above all others to be considered from the first and put into use, and even the "iron and steel frame" construction, if properly guarded in respect of the material used in floors and internal fittings, would meet almost perfectly this same requirement.

There would seem to be a bitter sarcasm in this destruction of any part of an engineering school outfit, especially at the very instant of its completion; a place where, above all things else, well-considered and sound construction should have the first place, if even a trace of the great fund of experience, which could be drawn upon, had been overlooked or neglected.

P. BARNES.

Pittsburgh.

[We publish herewith a view of the burned building, which we had intended publishing with a former note upon this subject, but did not receive the engraving in time.



It is undoubtedly true, we think, that in the construction of such a building much more attention should be paid to fire proof construction, or to the later and more practicable "slow-burning" construction than to architectural effect, though the two can be combined, probably, without much trouble. —ED.]

Pasting Blue Prints to Cardboard.

Editor American Machinist:

In regard to mounting blue prints, Question 68, cardboard is not stiff enough, bookboard should be used $\frac{1}{8}$″ or $\frac{3}{16}$″ thick; this can be had of bookbinders.

Wrinkles are caused by the print expanding under the moistening action of the paste.

Paste used may be flour and water boiled, and not very thin. Apply first to print, and while that is laying a few minutes to expand, apply to bookboard.

If blisters appear from air being imprisoned under the print, pierce them with a pin, and rub print down.

Lastly, a print worth mounting is worth preserving, and if they are varnished with bleached shellac, they can be washed with soap and water without injury.

J. C. MATHER.

To Harness the Tides.

Mr. Davies, of Wood Green, has embarked on a scheme which promises colossal returns. He intends utilizing tidal energy for electric lighting, tramways, and railways. The notion is not entirely new. In 1881, Professor Thompson pointed out that no fewer than twenty billion foot-pounds of energy were wasted each year at Bristol alone. One-tenth part of this energy would, it is stated, light the city with electricity, while one-tenth part of the tidal force of the Severn would be sufficient to illuminate every city in the empire. Scientific men have all agreed that the only possible mode is to have immense reservoirs, which would fill at high tide and run out on the ebb into the tidal way through turbines. To this there has always been one disadvantage. No inventor could show a greater length of efficient working power than six hours daily. Mr. Davies claims, after an immense amount of thought, a deal of experiment, and considerable outlay, to have invented apparatus by which he can work turbines from the rise and fall of the tides every minute during the twenty-four hours, at a saving of 400 per cent. over steam engines of similar power. His experiments, on a small scale, off the Cheshire coast, incline him to believe that it will speedily become an immense commercial success and an affair of national importance.—*London Figaro.*

The deepest boring, of which we have any knowledge up to the present time, is at Parvschowitz, in the district of Ribnik, in western Silesia. The depth attained is 6,568 feet, and the diameter of the hole is only 2.75 inches. The work has been temporarily stopped in order to lower especial thermometers, which have been made with great accuracy, into the hole for the purpose of obtaining the temperature at different depths. The boring will then be resumed, and it is hoped that a depth of 8,200 feet will be reached.—*Revue Scientifique.*

We are informed by the Secretary, Mr. F. H. Sipperly, that the Engineers' Club, of Brooklyn, has been formed for purely educational purposes, the proceedings of the meetings to consist of lectures, debates, etc., on matters relating to engineering. The meetings will be held Saturday evenings at 8 o'clock at Johnston Building, Fulton and Flatbush avenues, Brooklyn, N. Y.

The Page Belting Co., Concord, N. H., has published a World's Fair souvenir, illustrating a number of machines upon which their belting was used.

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J. G. A. MEYER, } Associates.
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Long Micrometer Screws.

A manufacturing concern interested in the use of micrometer calipers asks us why it is that no manufacturer is at present making such calipers with a screw traverse of more than 1″.

There may be many reasons known to manufacturers of micrometers, which do not occur to us, but those which do occur to us are, it would seem, amply sufficient to practically limit micrometer screws to 1″ traverse, and indeed to make them still shorter where circumstances will allow.

In the first place, we naturally have to consider the subject from the standpoint of the man who makes the screw and the nut in which it is to work. One of the most essential requirements of the case is accuracy of pitch, and, when this is considered, it is easily seen that the difficulty of keeping the total error below the allowable limit rapidly increases with the length of the screw, because if for any reason (and there are a number of possible reasons) the screw has a constant error, *i. e.*, an error which is uniform throughout its length, this error will, of course, be exactly proportioned to the length of the screw that is used, and, therefore, a screw out of true pitch by an amount not sufficient to be noticeable in a length of 1″, might have a very noticeable error in a length of 2″—the total error being in fact just doubled. In other words, the total error in, say, a 2″ micrometer screw would, under the conditions named, be twice that of a 1″ screw, and this means that every refinement used in the making of these screws would have to be, as it were, again refined in order to keep the work within the allowable limit of error. Take, for instance, the matter of temperature; it is very important in cutting accurate screws to see to it that the screw being cut is, at the time it is finished, at least very nearly the same temperature as the lead screw, some little variation in this respect being, however, practically allowable; but in the case of a 2″ screw, the permissible difference of temperature would be just one-half what it would be in the case of a 1″ screw, and so on with nearly every point which has to be looked after in cutting such screws, the significance of this being that micrometer screws arranged to traverse 2″ would, if having no greater total error, cost considerably more than twice as much as 1″ ones cost.

And from the standpoint of the user the long screws would probably be inferior, even if originally made as accurate. If a micrometer caliper were made to measure from 0 to 2″ by having a 2″ movement of screw, it would in the first place require that much more time be spent in merely turning the screw through a considerable distance preparatory to measuring something, than would be required with a convenient sliding movement of the anvil of 1″; or, better still perhaps, two micrometers, one to measure from 0 to 1″, the other from 1″ to 2″, to say nothing of the fact that with the former plan a micrometer far too heavy and clumsy would necessarily have to be used for measuring the smaller sizes, say up to ½″, which in many lines of work might constitute by far the greater portion of the measurements to be made.

This idle winding of the screw from one to the other of widely variant sizes would, of course, increase the wear of the screw and nut throughout the length of both, aside from the greater relative local wear of screw, which would take place when most of the measuring was done on small sizes, this local wear being still further increased by the fact that a practical length of thread in the nut for a 2″ screw would probably not be much greater than for a 1″ screw, a relatively short nut tending to increase local wear of the screw.

It is found also that there is usually in the act of measuring some deviation of the screw from its true central position within the nut. This is not usually sufficient to appreciably affect the accuracy of the measurement, unless the screw projects a considerable distance, in which latter case it prevents true parallelism between the contact surfaces.

The considerations mentioned, besides others not mentioned, lead those who make screws for measuring operations to make them short, and to depend upon a shifting or rather movable base for securing the desired range in any one machine or tool.

This was clearly shown in the bench measuring machines exhibited at Chicago; all of these having quite short traverse of the micrometer screws, and various means of establishing a new base at intervals proportioned to the screw movement; that for the German machine, by J. E. Reinecker, being by standard end measure pieces or bars, to be placed between the contact surfaces; for the Pratt & Whitney machine, a steel bar, with standard reference lines, read by microscope; and in the Brown & Sharpe machine, a finely graduated scale read by the same means, both the last-named machines being suited to the use of standard end measure pieces also if desired.

The Right of Engineers to Meet.

One who signs himself "Engineer" writes to *The Railroad Gazette* a letter the gist of which is a complaint that the monthly meetings of engineers for the discussion of technical subjects are not made official and the proceedings published in the volumes regularly issued by the society. Speaking of members so situated as to be able to attend meetings only occasionally or not at all, he says: "They are, however, interested in its doings, and if deprived of the privilege of reading verbatim reports of the meetings they will eventually object to the proposed practice of 'unofficial' meetings of members."

It is just possible, we suppose, that there might be members of the A. S. M. E. who might object to such meetings, but what possible ground there could be for any such objection it would be impossible to conceive.

It is well understood that the house of the society in New York is open at all times for the use of members, and that its library is public. Any member is at liberty to go there at any time, and may, if he chooses, meet other members there, and they may discuss matters of mutual interest, no obligation resting upon them or upon the society to prepare a report of what may be said, and to distribute that report to members who for any reason are not present.

The meetings which have been started are nothing more than a plan by which members may exercise this privilege in a systematic manner. There is no organization of these members who take part in the privilege; no list of members, and no dues or expense of any kind. A few technical papers have joined in paying the cost of a stenographic report of the meetings, primarily for their own use, and one manifolded copy of this report is kept on file for future reference if needed.

Our report of the first meeting, published in issues of 18th and 25th of January, was a full and complete report of all that was said in relation to the subject under discussion, and we think it perfectly safe to say that all that is of interest pertaining to what takes place at these meetings will be published, and will be accessible to any one who cares to read it at a cost of, say, 12 to 25 cents, so long as those who take part in the meetings consent to such reports being made and published.

If monthly meetings were held by the A. S. M. E., and the proceedings of these meetings made a part of the annual volume of transactions, it would very much increase expenses and perhaps make another increase of dues necessary; while at the same time any number of members who chose to do so might still meet by agreement to discuss matters of interest to them. If these members lived in the neighborhood of New York they might meet at the society's house, so long as the society did not object, and if it did object they might meet elsewhere, and in either case we utterly fail to see how any one would be defrauded of any right whatever. On the contrary, we think that so long as members, meeting thus, allowed their spoken words to be stenographically reported and published by technical journals, all engineers should consider themselves favored in the matter.

It is just possible that it might be advisable for the A. S. M. E. to organize and officially conduct monthly meetings of its members, not only in New York, but in other centers where members could conveniently get together. A proposition to hold such meetings would probably bring out many sound reasons both for and against it, but whether the society may or ever does hold such meetings or not does not in the least affect the right of members to get together at any convenient time or place for the discussion of any subjects they may choose to discuss.

As was to be expected, the report of the special committee of the House of Representatives appointed to investigate the matter of premiums paid for excess speed in new naval vessels, has found nothing to condemn in connection, except the methods and evident purpose of the man who seems to have been mainly responsible for the resolution calling for the investigation. Very few of those who know much of such matters have doubted that the money spent in speed premiums has been honestly and well expended.

Benjamin Eastwood, machinist and founder, Paterson, N. J., is to manufacture for the Safety Vapor Engine Co., 16 Murray street, New York, the engine illustrated in our issue of October 5, 1893.

Literary Notes.

A HAND-BOOK ON THE STEAM ENGINE, with especial reference to small and medium-sized engines. For use of engine makers, mechanical draftsmen, engineering students, and users of steam power. By Herman Haeder, Civil Engineer. English edition re-edited by the author from the second German edition, and translated, with considerable additions and alterations, by H. H. P. Powles, Assoc. Memb. Inst. C. E., M. I. M. E.

In this work the proportioning of different parts of the steam engine is considered from a practical standpoint; the theoretical part is treated very briefly, and only a very few formulas are given. The main and valuable feature of the book is found in the numerous tables giving the dimensions of details of different classes of simple and compound steam engines accompanied by suitable illustrations. These dimensions have been obtained from actual practice, many of them having been furnished by engine builders. This gives the book the character of a note-book, in which the results of observations and experience have been carefully and systematically tabulated. Although we do not advocate designing engines without carefully computing the strength of parts, and considering the design of each piece, a book of this kind is extremely valuable for a comparison of the computed results with existing designs, which will either inspire confidence, or cause further investigation. The book refers to English practice, and to prominent designs found on the continent of Europe. It is carefully edited, and bears evidence of reliability. We can recommend it to engineers, draftsmen, and all interested in the design of steam engines. It is sold by D. Van Nostrand Company, 23 Murray and 27 Warren streets, New York. Price, $3.

MINERAL RESOURCES OF THE UNITED STATES CALENDAR YEAR 1892. By David T. Day, Chief of Division of Mining Statistics and Technology. Published by the Department of the Interior, United States Geological Survey. J. W. Powell, Director. Price, 50 cents.

This volume shows the progress made in the development of the mineral resources of the United States in 1892. The statistical tables of previous years are carried forward from former reports of the series, of which this is the ninth. The book is divided by mineral topics which take the place of chapters. These are so arranged as to bring kindred subjects together. The work is the result of a census conducted by the principal experts in each subject. Their names are usually given at the head of the articles which they contribute. The Bureau of Statistics of the Treasury Department is cred-

ited with all the statistics of imports and exports.

In the summary given on page 1 we find the following:

"*Totals.*—The values given below for the various mineral products are those most commonly used in the trade. For the metals values are usually represented delivered at some prominent trade center. For the others 'spot' values are taken, *i. e.*, aboard cars at the mine and in the condition in which the materials first become articles of sale. Summing these values it is seen that the total value is $685,377,383. This is the highest value the mineral products have ever aggregated. It represents a still greater aggregate of quantities, for prices ruled lower than in 1891. With the prices in 1891 the total value would have exceeded $700,000,000. The effect of low prices will be felt in reduced production in 1893, although the several items concerning the production during the first six months of 1893 do not show as great a reduction as would naturally be expected." After this follows the production of iron and steel, iron ore, precious metals, copper, lead, etc., and miscellaneous materials. The articles by experts treating on the resources and production of minerals and their allied industries in the United States, are valuable and reliable to all interested in subjects of this kind, and contain information which cannot be as easily obtained from any other source.

Remittances for the work should be made by postal note (not stamps) and should be addressed to the Director United States Geological Survey, Washington, D. C.

QUESTIONS AND ANSWERS.

Questions of general interest relating to subjects discussed in our columns will receive attention in this department. The writer's name and address should always accompany the question. Neither correct initials nor location will be published when there is a request to that effect. If questions are enclosed with a business communication, they should be written on a separate sheet.

(86) G., Ansonia, Conn., writes: I would like to learn mechanical drawing. Are there any books published suitable for the use of beginners? There are none in this town. *A.*—The papers treating on practical drawing, published in our columns, will, we believe, answer your purpose. We can furnish these at any time desired.

(87) R. G., Philadelphia, Pa., writes: Kindly inform me if a horse can drag a bushel of wheat along an ordinary road, the length of rope between horse and wheat being 100 feet long? *A.*—Yes. You have probably heard of an old theory that as the distance between the load and horse is increased the power of the horse is decreased. This is a fallacy.

(88) C. F. D., Charlotte, N. C., writes: Please answer the following question: What is the rule for finding the diameter of a piston of a given area, either in whole or fractional parts of an inch? *A.*—Divide the area in square inches of the piston by the decimal .7854, and extract the square root of the product, the result will be the diameter in inches of the piston.

(89) J. M., Tina, Mo., asks: 1. Is there any attachment for a lathe for lengthening it out so that it will take in longer work than the bed provides for? *A.*—No. Doing this is a makeshift operation. 2. Where can I get a cheap second-hand screw cutting lathe about 20″ swing and 8 feet between centers? *A.*—Write to advertisers of second-hand machine tools.

(90) C. E. P., Paterson, N. J., writes: Please answer the following questions: 1. Will a strong brine have an injurious effect on a zinc lining of a tank? *A.*—No. 2. Can soft iron be permanently magnetized? *A.*—No. 3. Please give a description of ice machines and their operations. *A.*—See our issues of May 29, June 5, 26, July 10, and August 14, 1890.

(91) W. M., Dover, N. J., writes: Kindly inform me as to whether there is a tool in use for boring large cylinders without removing them from their beds. My friend claims it is done. I have never heard of it before in my experience. *A.*—We presume you refer to re-boring cylinders. Boring bars specially rigged up for this purpose have been in use for years. They are used for any diameter of cylinder.

(92) C. P., Brooklyn, N. Y., asks: What horse power will be required to drive twelve 14 inch lathes and four Brown & Sharpe universal milling machines? *A.*—A 14 inch lathe driven to its full capacity may require 2 horse power. But it is not likely that all the lathes will be driven to their full capacity at the same time, hence 10 horse-power for driving the twelve lathes will probably be a fair estimate. We cannot give the horse power required for the milling machines, as you do not give their size. However, by writing to the makers you will obtain reliable information.

(93) C. L. A., Holyoke, Mass., writes: Please inform me of the relative efficiencies of bevel gears, spur gears and belts used as mediums for the transmission of power. *A.*—There are comparatively few records of experiments made to determine these efficiencies, and there are so many conditions which will have an important influence on them that it is impossible to answer your question with any great degree of accuracy. Under favorable working conditions we should give the following estimates: For the efficiency of belts about .97; for spur wheels, .92, and for bevel wheels about .82 and upwards.

(94) A. B., New Orleans, La., writes: I have a tank which receives the water due to condensation; the steam pressure is sometimes as high as 75 to 80 pounds. I want to pump this water and steam into the boiler, but the pump which I have gives me trouble in keeping it packed, and in other ways. Please inform me through your columns what kind of pump is best adapted for this purpose? *A.*—Nearly all manufacturers make a special pump for the purpose. These pumps are usually operated by a hollow float in the tank and by means of intermediate connections. When the float rises the pump is started and the speed is regulated according to the quantity of water flowing into the tank. The pump slows down as the supply of water drops off, and when it ceases the pump stops entirely. By writing to any one of the prominent manufacturers of pumps you will undoubtedly get one that will answer your purpose, and work satisfactorily.

(95) E. H. H., Moro, Ill., writes: I ordered a set of boiler tubes 2¾ diameter, 16 feet long, from a hardware house. I cut each into three pieces of equal lengths. After getting them in my boiler I find them too hard to work, the bead will break off all around. I sent them back to the hardware house, and was informed that I should anneal them. I think that they should be annealed in the factory, as I am of the opinion that I cannot anneal them properly in the open air, and they should be annealed in a furnace in the tube factory. Please state whether I am right or wrong. *A.*—If your order called for annealed tubes, and the dealer sent you another kind, he should replace them by the kind ordered. If the order did not call for annealed tubes, you will have to anneal them, or pay for having it done. Although it is best to anneal the tubes in a furnace, you can, for the purpose of expanding the tubes, heat the ends in a blacksmith's fire, and let them cool slowly in lime.

(96) W. S., New York, writes: Kindly inform me how I can get employment in the drawing room as an apprentice? I have studied drawing for two years. Wherever I have applied for a job I am told that I could not be employed unless I am a competent draftsman, one who can design any machine. Now, how can I become competent if I do not get a chance to work and study under an experienced master of drawing? *A.*—Mechanical drawing in itself is not a very difficult science to learn, and does not require for teachers eminent men of genius, as the word "master" seems to imply. Draftsmen must be familiar with a far wider range of knowledge than simply that of mechanical drawing; they must have a fair knowledge of the various branches of mathematics, and it cannot be expected that these will be taught in a drawing room, although you may learn how to apply mathematics to everyday practice. Draftsmen should also be men of observation, and have considerable practical experience. In our opinion, the best place for observation, and to gain experience, is in the shop. We should therefore advise you to take a position as apprentice in a machine shop, continue your studies in the evenings and you will eventually obtain a position in a drawing room. If you do not like the idea of working in the machine shop there is another course left for you to pursue, and that is, take a course of engineering in a technical school.

(97) M. B. P., Durango, Colo., writes: We have a dispute in regard to the bursting of a pulley. Its dimensions are: Diameter, 5 feet; face, 10½ inches; rim, ⅝ inch thick; shaft bore, 2 7/16 inches; revolutions per minute, 450. It is a split pulley, and was used for driving a dynamo. The pulley was placed on a countershaft, and broke on each side of the joint close to the arms of the pulley. The rim bolts are ⅝ inch diameter, two to each joint. The two bolts were also broken square in two. The countershaft was driven by a 10″x16″ engine running at the rate of 210 revolutions per minute. Please state the cause of the accident. *A.*—It is difficult to state, with any degree of certainty, the cause of the accident, without an examination of the plant. From the data you have given, we should say that the accident was due to the high speed of the pulley. The circumference of a pulley 5 feet diameter is 15.7 feet, and when making 450 revolutions per minute, the speed at the circumference will be 15 7 × 450 = 7 065 feet per minute, which is too great in ordinary practice. The general rule is not to allow the speed at the circumference to exceed a mile per minute, or, at most, 6,000 feet per minute. We are aware that in some cases, when pulleys had been made, and material selected with extraordinary care, that this speed has been exceeded without any disastrous results, but in ordinary practice it is dangerous to exceed the limit of speed, as stated above. Summing up briefly, we should say that the primary cause was high speed.

(98) W. S., Reading, Pa., writes: Kindly let me know through your paper how to make a thermostat regulator rod and valve lever for an incubator to control the heat at 103 degrees. The lamp is so situated that its flue passes upward through the machine and through the radiator, at which point it is to have an opening in the flue through which the hot air from the lamp is diverted into a galvanized iron radiator covering the entire top of the egg chamber. After circulating through the radiator the air is to pass upward and out through the pipes at the end of the machine, thus equalizing the heat everywhere in the egg chamber. The regulator is to be a thermostat rod and a valve lever for opening and closing the valve on top of the lamp flue and obstruct the current of hot air, forcing it into the radiator as above described. When the temperature in the egg chamber reaches the desired degree the thermostat is to lift the valve from the top of the lamp flue and allow the heat to escape from the heater. *A.*—There are several kinds of thermostats made, but our experience in this line is limited, and we do not care to recommend any particular construction. The simplest kind consists of a bar composed of two metals, say steel and copper, having different degrees of expansion under the same temperature. This bar when fixed into position is made by simple mechanical means to open the valve. Another form of thermostat is made to break an electric current, and thus move an armature that controls the valve or damper. Another form consists of a balanced thermometer that, under the movements of mercury in a tube pivoted in the center in a horizontal position, will rise or fall and thus control the damper. The manner of attaching the thermostat will depend on the construction of machine.

(99) W. S. W., Reading, Pa., writes: Please instruct me through your columns what is meant by the term "radius of gyration" in calculating the strength of columns for compression? Please make your reply as simple as possible, as I cannot see the application of the term. *A.*—In the computation of the strength of columns, the term radius of gyration refers to the area of the cross section of the column. Before a column is subjected to flexure, all cross-section perpendicular to its axis will be parallel; after flexure these cross sections will not be parallel. These sections are supposed to turn about their neutral axis. Now, suppose the area of the cross section to be divided into a number of smaller and equal areas, or, in short elementary areas, then each of these areas will offer a resistance to flexure. To find the total resistance of all the elementary areas, involves the computation of the moment of inertia; this is found by multiplying each elementary area by the square of its distance from the neutral axis of the section, and adding all these products, the sum will be the moment of inertia of the surface or section. Now, dividing the moment of inertia by the area of the cross section, and finding the square root of the quotient, we obtain the radius of gyration. If I denotes the moment of inertia, A the area of the cross section of the column, and r the radius of gyration, we have

$$r = \sqrt{\frac{I}{A}},$$

which gives us

$$A\, r^2 = I,$$

a well-known relation between I and r.

(100) G. B. T., Chelsea, Mass., writes: Kindly publish a formula for ascertaining the proper thickness of plates in a stand-pipe 100 feet high and 40 feet in diameter; the courses are 5 feet wide. *A.*—The thickness of plates will depend on the quality of the material used, and the kind of riveted joint adopted. Assuming that the longitudinal seams are lap joints double-riveted, and that the material is iron whose ultimate tensile strength is 45,000 pounds per square inch, and adopting a factor of safety of 2¼ for the riveted joint, we may allow a safe stress of 12,600 pounds per square inch of the iron. For finding the thickness of any course of the stand-pipe, the following formula is used:

$$\frac{P \times R}{12{,}600} = T;$$

in which P = pressure per square inch, R = inner radius in inches of stand-pipe, and T = thickness of metal in inches. The pressure P at the bottom of the pipe is found by multiplying the height of the stand pipe in feet by the weight of a column of water 1 foot high and 1 inch square; the weight of this column is .434 pound. Hence the pressure at the bottom of the pipe will be 100 × .434 = 43 4 pounds per square inch. Substituting this pressure for P in the formula, we have for the thickness of the lower course:

$$\frac{43\,4 \times 240}{12{,}600} = T = 0.826 \text{ inch.}$$

The pressure on the next course is due to a column of water 95 feet high, hence the pressure per square inch will be .434 × 95 = 41 23 pounds. Substituting this pressure for P in the formula, we have:

$$\frac{41.23 \times 240}{12{,}600} = T = 0.785 \text{ inch}$$

for the thickness of the second course. The pressure per square inch in the third course is due to a column of water 90 feet high, hence the pressure in this course will be .434 × 90 = 39 06 pounds per square inch, and the thickness of this course will have to be:

$$\frac{39.06 \times 240}{12\,600} = T = 0.744 \text{ inch.}$$

In a similar way the thicknesses of the other courses can be found, or we may employ a much simpler way. It will be noticed that the difference in thickness as computed above is .041 inch, and since the depths of the courses are equal, the thickness of each course will be 041 inch less than the preceding one. The thicknesses of the courses near the top of the stand-pipe are determined by practical considerations; these courses must be thick enough for calking.

BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Grant's Gears, Lex'n, Mass., & Phila., Pa. See p. 12.

Forming Lathes Mer. Mach. Tool Co., Meriden, Ct.

Milling Machs. Kempsmith M. T. Co., Mill., Wis.

Turret Drills, 6 spind es. A. D. Quint Hartford, Ct.

Chucks, the Nat'l. est'd 1882 39 Cortlandt St., N. Y.

Speed Gage McLauthlin & Co., Fulton St., Boston.

Pattern and Brand Letters A variety of sizes and styles. Heber Wells, 8 Spruce St., New York.

Davis Key Seating Machines kept in stock by Manning, Maxwell & Moore, 111 Liberty St., N. Y.

Selden Packing for stuffing box, with or without rubber core. Randolph Brandt, 38 Cortlandt St., N. Y.

Pulley lathes, most efficient offered. The Lodge & Shipley Machine Tool Co., Cincinnati, O.

Steam Pressure Regulators, Reducing Valves, Safety Checks, Foster Engineer'g Co., Newark, N. J.

Upright Drills, stationary head, W. & L. with or without B. G. J. E. Snyder, Worcester, Mass.

M. E. Howard, Indianapolis, Ind. Specialty, 4 and 8 H. P. engines in stock, write for price.

American Packing Rings make pistons steam tight. Are simple, durable and inexpensive; write for circular. J. H. Dunbar, Youngstown, O.

Guild & Garrison, Brooklyn, N. Y., manufacture steam pumps, vacuum pumps, vacuum apparatus, air pumps, acid blowers, filter press pumps, etc.

Improved Duplex and Special Gear Cutters in stock and to order; Gear and Milling Cutters of all descriptions. R. M. Clough, Tolland, Conn.

"Pumping Machinery." New book, 450 pp. 8vo, 270 Eng. Prospectus free. W. M. Barr, 3223 Powelton Avenue, Philadelphia, Pa.

Blue printing a specialty. Jigs and tools designed for all purposes. Drawings perfected. Send for estimate. L. C., Box 464, Madison, Wis.

New Jersey Art Metal Co., Passaic, N. J., finest thin and ornamental castings in brass, bronze, aluminum, etc.; machinery name plates in brass and aluminum.

"Binders" for the AMERICAN MACHINIST. Two styles, the "Common Sense," as heretofore sold by us and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers with full page opening flat. Either will hold the entire 52 issues of any volume. AMERICAN MACHINIST PUBLISHING CO., 203 Broadway, New York.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator and making all required calculations from the diagram, also the principles of economy in operating steam engines and current practice in testing engines and boilers. Price, $2 postpaid. Published by John Wiley & Sons, 53 East Tenth Street, New York.

Aluminum.

In "The Mineral Resources of the United States," some information about aluminum is given, which, while not new, may not be generally known: In weight wrought iron is 2.9 times heavier, while structural woods are about one-third as heavy; a cubic inch of aluminum weighs 0.092 of a pound. Its

ability to resist corrosion is one of its valuable properties. Aluminum is scarcely affected by sea water, and is practically unaffected by steam or hot water. The best polish for it is said to be, stearic acid, one part; fuller's earth, four parts; and rotten stone, six parts, by weight. The whole is powdered very finely, and run through a bolting cloth sieve. It is known as "almeta polish." Ordinary brass polish will answer fairly well. In spinning or turning aluminum plenty of oil should be used. The tensile strength of aluminum is about the same as cast-iron of equal section, and about the same as of steel of equal weight. Some of the solders that have been used for aluminum are, tin, 1,000 grains, lead, 50 grains; tin, 1,000 grains, zinc, 50 grains; tin, 900 grains, copper, 100 grains, bismuth, 2 to 3 grains; tin, 1,000 grains, nickel, 10 to 15 grains.

Second Monthly Meeting of Mechanical Engineers in New York.

According to previously announced programme, members and friends of the A. S. M. E. met at the society's house the evening of the 14th inst. There was a good attendance; in fact, the auditorium was comfortably filled.

After some little consideration of pecuniary matters connected with the meetings—during which it was stated by the Chairman of the Committee (Mr. Forney) that two gentlemen (whom he did not name) had each given $50 to defray expenses for the present—Professor John E. Sweet, of Syracuse, was introduced, and spoke as follows:

Mr. Chairman and Fellow Members:

If I rightly caliper the aim the promoters of this monthly-meeting scheme had in view in selecting some one member to open the discussion, it was with a view of having that individual discuss something of interest, or say something that shall inspire others to discuss it; and the object of the discussion is for the exchange of thought, the advancement of our engineering knowledge and practice, or the heralding of our mechanical achievements as a sort of mutual admiration society in disguise.

After all that was said about the modern steam engine at the previous meeting, there is but little of interest left for me to say, and my only hope lies in saying something that will strike flashes of inspiration from others. There are two ways to promote discussion; one to say something the listeners like to hear, whereat many are ready to add their hearty endorsement, and the other to say what they do not like to hear, which will bring up as many to refute the assertions.

Assuming that you will all agree that the latter plan is likely to make things more lively, your committee may well congratulate itself in having selected for this purpose one whose proverbial modesty entitles him to the privilege of ridiculing the past, finding fault with the present, and criticising the future; besides abusing the fraternity in general.

In considering the present let us review the past, and, trusting you will allow me, I will go back to the first step in the stairway of my interest in steam engineering—the exhibition of the Royal Agricultural Society, at Battersey Park, in London, 1862, or 31 years before the Columbian Exhibition at Chicago.

I remembered that there was a lot of portable engines there and so turned back to some printed letters written home at that time and find this paragraph: "But one still greater feature than all was the almost incredible number of portable steam engines, 83 different ones, all with steam up and going at the same time and driving threshing machines, straw-cutters, grist-mills, tile and brick machines, etc. Six or seven were traction engines."

To this I might add something about steam plowing, which was then and still is successfully practiced in England, and the steam-road rollers which were common, but I do not call up this subject to show how we outstrip all other nations (in following in their footsteps), but to call attention to this branch of steam engineering (which has not been thus far considered), and to describe one of the many things I saw at Chicago which excited my liveliest admiration.

A traction engine (not of the largest size) built somewhere in Ohio, well invented, not very well designed, frivolous in some of its details and deplorable in workmanship, was harnessed to a five ton load of pig-iron piled on a stone-boat. The engine hauled that around over the dry ground with as much indifference as if it had been so many pigs of pork. It went down into the canal, wallowed around like a sea-lion and out up a bank where one would not expect to see a team draw up a wagon. It was driven up to a railroad track where the ties had been blocked up until the tops of the rails were two feet above the level. The engine mounted this obstruction diagonally, first one forward wheel then the other, then alternately the back wheels in like manner, running along over the ties and turning off diagonally as it had mounted; in fact, performed the feat precisely as an elephant would have done and with like ease and indifference.

I was so astounded at this exhibition, so elated to see the justifiable pride shine out of the builder's countenance, that I did not stop to consider then, as I hesitate to question now, whether it would not have been better to build the engine with less of the spirit of a gymnast and more in line of durability in its legitimate work. Allowing the thing to be worth doing, the man who did it is never likely to receive half the credit he deserves. When the means are compared with the end, the builders of stationary engines and locomotives may take off their hats to the builders of traction engines and call them brothers.

As the Cornish pumping engine set the pace in steam economy for half a century, so the Cardiff trial of portable engines, 20 years ago, set the mark so high that small engines of no kind have as yet in this country approached it. Compound portables have long been common in England though they have not yet appeared here.

To go back to the same year '62, the year of the second London Exhibition, my memory does not even picture the steam engine exhibit, but I remember Mr. Porter exhibited a rapid running engine, and patented, introduced and promoted the manufacture of the Richards indicator.

The next step on the exhibition ladder was the Paris Exposition of 1867. At that exhibition two engines of mark beyond all others set their hands upon the industrial world and have held them there for a generation—the Corliss engine from the parent works at Providence and the Porter-Allen, built by Whitworth. While the Porter-Allen was admired and the maker's name commanded respect, it was too novel, untried, or for some reason did not take root in Europe. The Corliss engine, new to the Continent, was admired for its silver jacket, polished bonnets and general trousseau, ridiculed for its complexity, but understood by the leading engineers of Europe. Although Mr. Corliss had no Continental patents, it was taken up by three or four of the leading manufacturers and royalties paid the same as if he had held patents. Honorable deeds certainly, and if they have been reciprocated in like manner to the least extent the fact is not generally known. In plain English, if any American has paid a foreigner royalty on an unpatented invention some of his friends should make it known.

While the natural sons of neither of these engines (the Corliss and the Porter-Allen) were shown at Chicago, what Chordal designated the "Hyphen-Corliss" and what may be styled the Fitz-Porter engines were too numerous to escape attention; in fact, they constituted the bulk of that wonderful collection in Machinery Hall. It may be true, and likely is, that there were high-speed engines built before the Porter-Allen engine, but it is one that still lives, and, I fancy, one that has suffered least by changes and modifications, certainly, least of any in looks; it is the respected parent of a numerous group of sons and daughters-in-law that I shall speak of later.

Mounting the third step of our experience, the Centennial. While compound engines were quite common in Europe and on the sea, and Adamson had, I think, built his quadruple, none were shown at Philadelphia; in fact, our own engineers did not believe in them, and while the single-cylinder engine has been transformed into many shapes, it had then reached a pretty high state of completeness. The Buckeye engine, the only engine shown at both Philadelphia and Chicago, having reached about the form it followed for many years, and the Corliss, the double, single-cylinder, walking beam, 30 feet cut gear, center piece, was the grandest steam engine monument in its impressiveness, ever erected. But, judged in the light of the present practice, showed (as Mr. Porter pointed out at the time) just how not to do it. In explanation of this statement it may be well to give the substance of a friendly criticism of the great Corliss triumph, held under its own shadow. It was, as you all remember, a beam engine with two 40-inch cylinders, 10 feet stroke, two walking beams coupled to the two cranks of a shaft carrying a 30-foot gear, working into a pinion some 12 feet in diameter, the engine making from 35 to 38 turns, and the second shaft about 90. By what process of reasoning our conclusions were arrived at, I do not now remember, but it was agreed that two 40 inch cylinders at 4 feet stroke directly connected to the second shaft, and run at the same piston speed, would accomplish the result at an immensely less expense. The whole Chicago display shows that is what would now be done, and while Mr. Hemenway allows there has been a gain in pumping engines of only 20 to 25 per cent., I am sure the Allis Chicago engine will harvest two horse-power from the sowing of the same amount of coal that it would take to get one from the Corliss Centennial. Which, as it was specially suited to compounding, and yet was not compound, shows that Mr. Corliss, at that time, had not been convinced that there was enough advantage to go to that slight additional expense.

I am well aware that it is almost sacrilegious to criticise the design of that wonderful Centennial monument, but shall do so in the belief that the very audacity of the thing will emphasize the point I wish to make. The design was in two distinct styles intermingled—just the wrong thing to do as well in machinery as in building. The framing was of the most severe straight lines, almost seeming to be simply a reproduction in iron of its wood prototype, while the beams were in graceful curves, and the lever arms of the valve motions, not curves, but crooked and freely graceful. Milan Cathedral and this Corliss engine are noble examples of mixed architecture, but noble in spite of the mixture and not because of it.

When one sets himself the task of looking into this feature of machine design, he will find in it one of the explanations of why things do not look right. There is an engine of recent production, where the arms of the wheels are elliptical, a conspicuous lever I section, rocker arms round, cylinder head one style and steam chest covers another, and yet there seems no apparent reason why, if the machine was consistently designed, it would not accomplish the impossible just as well as it does now. I am well aware of the danger one encounters in criticising designs, and to simply say one looks well and another not, without giving the reason, is setting one man's opinion against another's, but, certainly, there is such a thing as consistency, which plainly is subject to demonstration.

Builders of the modern improved Jones, Smith & Brown Corliss engines, found themselves confronted by this condition. Steam pressure had gone from 60 to 120 lbs., and something had to be done to meet the new conditions. Three methods were open to them: Put in more iron, put it in a better form, or make more attachments to the foundation. As is usual with improvers the most of them took the wrong road. Hicks & Hargraves, of Bolton, England, adopted the right plan on the start by making the frame a complete box. The only Hyphen-Corliss engine exhibited at Paris in '67 was of this make and this form. At Chicago, two of the Corliss type claimed to be box section, but the builders spent some money to spoil them by cutting ornamental holes through their vital parts.

A round column (not more than 24 diameters in length) cannot be improved, except by putting more metal in it. In any other form it can be improved by making it round. A round tube is not a suitable form for an engine bed; a rectangular one is, and is nearly as strong as a round one. Aside from the push and pull the strain on a Corliss bed is a torsional one. A rectangular box will resist this strain about sixteen times better than an I beam of the same cross-section. Against a push and pull strain a crooked element is a weak one; if it must be crooked a box section is best able to resist it, but why crooked? There is plenty of room around a Corliss engine to make a bed straight and have it right, and when it is right, it will look right, provided the designer has the ability and the observer the right training. This in no way means that everything should be straight, for as often, perhaps more often, the thing to be right has to be the furthest possible from that, and the one who makes the thing straight that should be crooked, makes a worse blunder than the other.

As mentioned before, if there are two roads for an imitator to take to improve an original design, he will take the wrong one; so, too, if there is any one feature that is bad or less meritorious than another, he is sure to stick to that with a persistence worthy of the best and mutilate the subtle beauties he cannot appreciate; and this confirms me in the notion I have always entertained, that the overhanging cylinder of the Porter-Allen engine is not right.

Of the dozen or two of engine builders, both those who allow that their engine beds are of the Porter-Allen type, and those who build the same thing without the allowance, adhere persistently to the overhanging cylinder and remodel the graceful contour of the bed (which has never been equaled) with a freedom wonderful to behold.

They not only hang to the overhanging cylinder, but hang on another one, in looking at which I can only think of an old man turning his back to the job, catching his boy and holding him out at arm's length and the two working away, with the old man's posterior as the business end of the combination. Some of them fearing the boy will get tired, put a crutch under his back.

In the most recent developments of the man and boy scheme as it appears to me, the old man sits down on the foundation and takes the boy in his lap; each, however, true to his association, holds to the overhanging cylinder. As to which of these two is the best, I am reminded of a story.

I do not underestimate the animosity I am likely to excite by criticising designs, and offer the following in justification—not in justification as to the right and wrong of my opinions, but in justification of doing the thing at all. We all of us talk about each others' plans, whether cross, compound, tandem, quarter cut-off, clearance, horizontal, upright, Corliss, Willans, Sultzer, triple expansion or valve gear and all the rest of it, without any feeling in the matter whatever, and steam engineering has been immensely benefited by it.

Artists—the most jealous of all people excepting musicians—criticise each other's work and submit to the irrevocable decision of a hanging committee, and how are we to improve our designs better than to submit to the condemnation of our bad work by others and applaud the good in theirs. It seems as if the question of whether cabinet work is an appropriate adjunct to a steam engine or not could have but one answer and still it goes on, and I really suppose it looks nice to most people when new and horrid to everybody ever after.

It would seem after the example set by the Reynolds-Corliss, the Buckeye and the German engines at Chicago, that we would soon see the last of it, and this leads me to the final step—the Columbian Exposition.

Through the kindness of the various builders, I have been able to get a pretty accurate statement of the number, size, kind and power of the various engines of from about 100 horse power and upwards. The list does not comprise the small engines, of which, perhaps, there was 150 horse power all told, nor does it include pumping, air compressing, gas engines, portable or semi-portable, of which no guess even has been made.

There were, 23 single cylinder engines, aggregating 3,700 horse-power; 44 compound engines, aggregating 21,155 horse-power; 8 triple expansion engines, aggregating 8,425 horse power, and one quadruple engine of 3,000 horse-power, making in all 85 engines, of a total of 36,840 horse-power, exceeding the "Campania" by 7,000 horse-power; making it likely the greatest aggregation of steam power ever assembled in so small a space.

Comparing the work of the present with that of 17 years ago, the Centennial with the Columbian, Chicago with Philadelphia, so far as the use of the steam engine is considered, it is a change from single cylinders to compound, triple and quadruple expansion, and the generation and development of the single balance valve, shaft governor, high-speed engine. But so far as the production of steam from the combustion of coal, the best of to day is but little better, if any, than the best of 1876, nor is the average to any great extent better than then. Boilers have been improved so that higher pressures are as safe to day as the lower pressures were before, and as more power is obtainable from high pressures than from low to this extent has the modern boiler contributed its share to the improved economy. Water-tube boilers were wholly employed at Chicago, but that is no gauge as to what is the practice of the country, and only indicates the tendency which points as much towards higher pressures as it does towards the water-tube varieties, and the water tube is gaining because of its ability to carry the high pressures.

An incredible amount of work has been expended on boiler and engine room auxiliaries, some of unquestionable and much of questionable merit. Nothing has come to supersede the Worthington duplex steam pump as its many copies confirm, wasteful as it is said to be in steam economy, and the various forms of steam injectors are mostly modifications of the original, and they hold about the same relation to the steam pump as they have for years. There are many new and many modifications of both single-acting and duplex pumps and many modifications of the injector, mostly double, using the principle of the inspirator, but the main improvements have been in the simplifying of the number of handles to be operated, and in the devices that make the injector self-starting. Economy in the use of steam, either in the steam pump or injector does not appear to have made much headway. At least, the more economical have not swept the old aside to such an extent as the automatic engine has superseded the slide valve throttling sort.

Boiler feed heaters have taken on new forms, with likely constructive and possibly with operative advantages, but with little strikingly new in principle, otherwise than where heaters and filters are so combined as to better rid the feed water of its impurities before entering the boilers. Treating the water with chemicals and filtering is probably the most recent and advanced change that has been made.

Various new boiler compounds have been compounded, but what advance, if any, has been made, is in a wider understanding that the remedy must fit the disease. Just so far as compounds or filters prevent incrustation or contribute to keeping the boilers clean, just so much they have contributed to economy, and if all fixtures are credited with the saving claimed, they far more than make up for the increased boiler efficiency, so that boiler-makers may be falling back rather than progressing in the economy of steam production.

Automatic damper regulators, high and low water alarms, sediment pens, automatic boiler feeders, improved grate bars, mechanical stokers, various steam and oil separators, and the steam loop, have been studied over, changed, improved, perfected or invented and applied during recent years, and these, too, in their way have contributed to steam economy, but in no one has the change been more marked, or results so advantageous as in the engines themselves.

Considering the engine exhibits at Chicago, in the order of their magnitude, the 7,700 horse power of Westinghouse, Church Kerr & Co. was so far beyond anything ever before shown by one exhibitor as to set aside comparison. Their standard and compound engines which have been on the market for a decade, call for no comment, except that inspired by the wonderful growth of the industry. To install an experimental engine at an exhibition is a very risky thing to do; to install six experimental 1,000 horse-power engines of entirely new design, embracing untried mechanical devices, was a courageous thing, and one that entitles the company to as liberal consideration as the result requires to make the account stand on the creditable side. The new feature of air spring to balance the weight of valve mechanism, and at the same time to serve as a starting bar, was as good a scheme as the other good schemes shown by other builders.

The 3,000 quadruple Allis was too large for my comprehension, and I only raise the question whether the addition of the new feature to prolong the cut-off, and thus increase the range of power, is the best way to accomplish the result.

The Willans' experiments tend to show, so far as experiments with his style and size of engine can determine, that the superiority of automatic cut-off over throttling is less conspicuous on a compound than on a single cylinder, and shows that there is no economy at all in a triple expansion. If this applies to all multiple cylinder engines then it may be possible that it is the best plan to reduce the valve motion to the simple elements, and govern by a throttling governor. If this will hold good in the case of the Allis engine, of course, the same points come up in the Buckeye, Frazer & Chalmers, and others showing novel motions whose aim is in the same direction.

There is a more or less tendency to mix the shaft governor and Corliss valve, as shown by three or four different examples, the aim being to retain the good points of the Corliss valve, and be able to run at higher speed; a promising scheme.

One word about the Bates drop motion. If it is as good as the detachable arrangement, then they can pride themselves on having something of their own, and while it does not place them above the first step on the Corliss monument, it puts them one step above those who only follow the original. I cannot follow out the list, noting every improvement each engine builder claimed, many good, perhaps one as good as another.

Among the marked novelties in engines, I mean a complete engine, that by De Laval, of Sweden, was one of the most conspicuous. Being myself the grand nephew of a rotary engine, and this being a rotary engine, I speak as a relative and venture to predict that notwithstanding the ten thousand American patented rotary engines, this little Swedish bumble bee of a thing is nearer seeing the daylight of success than any other before exhibited. While it employs the principle of a Pelton water wheel it possesses just those additional elements not in the Pelton wheel that give it promise of success.

The Willans engine while nearly as old as many well-known American engines, is new to us, and remarkable in many respects, but particularly for its economy in spite of what we have supposed to be detrimental features—throttling, single-acting, mechanically fitted valves and high speed. But these defects, whether imaginary or real, are overcome or neutralized, and other advantages come in naturally, so that while at first sight the claims for its economy are questioned there is a lot of genuine steam engineering in it. Besides the low clearance, free escape for water and no loss from compression, the main thing lies, I believe, in the fact that the steam end of neither cylinder is ever in communication with the one of lower pressure or with the condenser. I spoke of the enormous growth of the Westinghouse, that of the Willans has been phenomenal—20,000 horse-power last year. We are prone to joke over the slow conservative English, but perhaps they know a good thing when they see it, after all.

For great power in small space—the claim we make for our high-speed engines—it seems to me about an even send off between the Westinghouse, Willans, and that crowning feature of the engine display, the triple expansion 1,200 horse power in the German exhibit. Personally, I have not much to say about this engine. Although I went by it several times a day for three months it was never my good fortune to be there when they were making repairs, and so I could see no more than other visitors. Another engine of like power, and occupying much more space and far more pretentious, seemed to be in a chronic state of repair.

Of all that was said at the previous meeting nothing pleased me more than Mr. Holloway's remarks about the Creusot engine. It was not only by far the best piece of machine work I ever saw, but up to the present time I believe it would be utterly impossible to produce the like in this country, and for the same reason that we could not produce work like the Venus de Medici or Raphael's Transfiguration.

As shown by the exhibits at Chicago the standing appears in this way. The largest and most economical, and probably as economical as has been thus far built, was the Allis engine; the largest exhibit by any one firm was that of the Westinghouse, both American; the most economical high-speed engine, the Willans, English; the best piece of steam engineering, the German; the best rotary, Swedish, and the best workmanship, French.

As to the future I think we may look forward to using better judgment as to putting the right engine in the right place. There is a right and wrong place, if not for all, at least for several kinds. The claims against the high speed are that it is not economical and terribly prone to smash-ups, claims pretty well founded, but in spite of that it has built itself up and was the means of building up the largest half of the electric-light business. As to its wasteful use of steam that has been overestimated and is fast being improved, and as to the smash-ups better separators and safety devices, and the destructive fly-wheel accidents of the last two years of slow speed engines, put the boot on the other foot. With the high-speed engine and Mr. Porter came better work and much better yet is needed and will be demanded, for there is a place for the high-speed simple engine that nothing else can fill. There is, too, a place for the Corliss engine and a place for the compound, though already many of them have been put in the wrong place. There is a place and as yet a good deal of unoccupied space for a vertical direct connected machine, and places for the triple and quadruple expansion. There is a show for better designs, a show for better workmanship, especially in castings, and as to the show for improvement in steam engineering, I can only reply as Barnum did when asked what he thought his chances were for heaven. He said he "thought he had the greatest show on earth."

MR. HOLLOWAY: Being myself a product of the Buckeye State, I was very glad to hear what Professor Sweet had to say in regard to the engine which he saw at the Fair performing some very unique operations, and I was surprised that he commended it so highly, because it went in a diagonal way instead of a straight line.

Now, in regard to the Centennial engine, it is true it was a monument in very many ways. That it was not the best kind of engine for the general user has been proved by its being removed to the Pullman Palace Car Works and set up as a show, I believe, while other engines are doing the work.

I agree very heartily with what the Professor said in regard to the characteristics of the different engines that were there, and it shows that he has observed them with a great deal of care, and has described them with a good deal of judgment. I spent only a few days there myself, and am not in position to talk very much about the machinery in general. Still there were some very commendable things there in steam engineering, and while there were not so many wide departures from what we had seen before, yet the matter of compounding engines has brought in new engines and new developments, and in that respect, of course, it was different from anything that we had before.

MR. CARTWRIGHT: There is one feature Professor Sweet has spoken of, which I heartily agree with. I am not connected with any engine works, but I have to use engines for different purposes, and when he says you may have the right engine in the wrong place, I think he says a great deal. That, certainly, has been my experience. My Board of Directors oftentimes say, "Why, Mr. Cartwright, you certainly will put in a Corliss engine." "No, gentlemen, I would not have a Corliss engine in that place. A Corliss engine is good where you are running 26 hours out of the 24 for the year right along, but I would not put a Corliss engine in where I was using it intermittently." I have one engine that in two years never has turned over but one-half day, but she did turn over when the call was made on her. A Corliss engine would not do that, according to my experience. You cannot lay up a Corliss engine as easily as you can lay up some others. I put in a Greene engine. The Professor did not bring in the Greene engine, I believe, in enumerating the engines he spoke of. I think it is a very good engine. Mr. Sweet was at Chicago three months. I was going to say I was there three days, and, of course, I could not see as much as he did, but I did take off my hat to the German engine. I think it was the only engine on the ground there that was a first class engine. When I asked these different parties why this was, they would say, "I will tell you, Mr. Cartwright; the foundation is so poor here that you cannot get in any engines." But you saw that German engine working there, and she did her work perfectly. I never saw a better exhibition of an engine in operation than she was, and I admired her thoroughly.

In relation to the big Corliss engine at the Centennial, it was a grand monument. It was a very pretty picture. But it had a great many defects, as we afterwards learned. They had two beautiful staircases up to the beam. Those staircases were not in the original design of the engine, as I understand it, but they were put there to hold her up. They were put there as side braces, to take the lateral motion. The Buckeye took my attention at the Centennial.

Now, I have just installed a plant for 4,000 horse-power. I put in a Woodbury balanced slide valve engine and am perfectly satisfied with it; 167 revolutions out of a 500 horse engine, and she does work magnificently. She will be an intermittent engine, because when we have no water we will call on the steam. We may have it for a year and we may not have it for three months. I got up more to reinforce the Professor's remark in relation to the right engine going into the right place.

MR. WILLIAM KENT: We have heard a great deal of commendation of the German engine, but no reasons have been given. I would like to ask Mr. Cartwright what is the difference between that German engine and the marine engine. It seemed to me that it was simply a marine engine put on land. Why shouldn't we put a marine engine on land, and what is the difference?

MR. CARTWRIGHT: Brother Kent, it was a marine engine.

PROFESSOR SWEET: With a governor attachment. That makes a good deal of difference. That is where the difficult part of the problem comes in.

MR. LE VAN: I would like to ask Mr. Cartwright why a Corliss engine cannot be kept idle a year, and then run?

MR. CARTWRIGHT: My experience with the Corliss engine is that it needs the doctor very often. We have handled a good many of them. A Corliss engine cannot be repaired by any machine shop; it may be done, but special machinery is better. Take a Greene engine, for instance, we have there all the advantage of the drop cut off and the plain slide-valve. Mr. LeVan and I were boys together and we did not have any machinery, and we took a hammer and chisel to do our repairs. But with a Corliss engine you have got to have special machinery to repair it properly.

Professor Sweet writes us since his paper was in type that he did not know at the time of writing it that the Willans engine people practically conceded a slight gain for automatic cut-off in the triple expansion engine; had he known it, the paragraph in which this was referred to would have been modified.

(To be continued in our next issue.)

Fire in Machinery Hall.

At 11 o'clock A. M., February 14th, flames were discovered in the southeast corner of Machinery Hall, at Jackson Park, by one of the guards, who also saw two men crawling through a window in the building. Efforts were made to extinguish the fire and alarms sent in to the fire department. Owing to the snow the engines had great difficulty in getting to the fire, and it looked at one time as if the entire building would go up in the blaze. As it was, one end of the building was destroyed, but no machinery, we believe. Much of the statuary and adornments around the building was destroyed. During the fire an explosion occurred that blew out some of the east wall.

The reason why the Massachusetts Institute of Technology is in need of funds is not, as shown by President Walker, because of lack of business, but exactly the reverse. The demands made upon the institution are constantly increasing, and the need of means to meet these demands is pressing. Every one will hope they will be forthcoming. Some rich philanthropist who wants to see his money do good work could scarcely do better than to place some of it at the disposal of this school.

MANUFACTURES

The rolling-mill at Piqua, O., has resumed.

The Berkshire Knitting Co., at Pittsfield, Mass., has resumed.

The Portland (Me.) Foundry Co. has started up with 75 men.

The Williamsport (Pa.) Machine Co., have started on full time, working 10 hours per day.

The Rowley & Mennance Co., of Williamsport, Pa., have started working 10 hours per day.

The piano factory of Rice & Holden, at Leominster, Mass., was recently destroyed by fire.

The main building of the Colts Firearms Co., at Hartford, Conn., was recently destroyed by fire.

Coal has recently been discovered at six different points in Moore County, N. C. It is hard bituminous.

Last September 462 sets of woolen machinery were idle in Worcester County, Mass.; now, only 154 sets are idle.

The McShane Manufacturing Company, Baltimore, Md., will rebuild its plant that was destroyed by fire on the 10th ult.

The Raleigh (N. C.) Hosiery Yarn Mills have been in operation three years, and during that time have paid 35 per cent. in dividends.

The New Jersey Copper Extraction Works, at Elizabethport, which suspended some weeks ago, will resume operations with about 500 employes.

The Standard Steel Works' large plant, near Lewistown, Pa., is now so pressed with orders that it is operated on double turn, giving work to 200 extra men.

The new trousers factory at Charlotte, N. C., is nearly completed. It will begin with thirty machines. They will be run by electricity and operated entirely by girls.

The Milwaukee Carving Co., Milwaukee, Wis., has issued a circular illustrating their carving machines, which are coming to be extensively used in woodworking establishments.

The following dispatch is from Troy, N. Y.: The Troy Steel and Iron Works will resume operations on full time on February 26th. This will give employment to about 500 idle men.

A large boot and shoe manufacturing concern in Brockton, Mass., has restored the ten per cent. reduction in wages made in the cutting and stitching departments some time since.

A Manchester (N. H.) dispatch says that the Jefferson Mill, of that city, will run four hours a day overtime to fill orders, and that the same is the case at the Manchester print works.

The Williams Rolling-mill Company, at Muscatine, Iowa, is operating its entire works double turn. It is stated that it has orders booked covering its January and February output.

"Up to Date" is the title of the latest folder issued by the Lunkenheimer Company, Cincinnati, Ohio. It illustrates and sets forth the newest in the "Lunken" renewable seat gate valve.

A Boston syndicate has arranged for the purchase of the extensive granite quarries in Rowan County, near Salisbury, N. C., and will put in the machinery necessary for their development.

The Britton mill, Cleveland, O., has let a contract to a Pittsburgh firm for a continuous mill, and the Ohio Steel Company, of Youngstown, has let a contract for machinery, to a Pittsburgh company.

The Clayton Air Compressor Works have removed their offices and salesrooms to the second floor of the Havemeyer Building, 26 Cortlandt street, New York, retaining their former store as a warehouse.

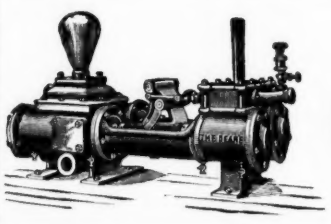
The furnishing of the new addition to Poole & Roach's mill, at Taunton, Mass., will be put in at once. They will include an engine and boiler, and also the machinery for rolling out the metal used in the shop.

The Atlanta, Ga., glass furnaces have started up again, after having been shut down for nearly a year. The new owners are James Rogers, an English glass manufacturer, and F. D. Bloodworth a Georgia capitalist.

A committee of Birmingham (Ala.) citizens, headed by the mayor, is conferring with James G. Caldwell, president of the Birmingham Rollermill Company, relative to the resumption of operations at the rolling-mill.

The Duquesne tin plate works, of Soho, Pittsburgh, is running its plant double turn, with a full force of workmen. It has received a large number of orders recently, which are sufficient to keep the plant running for several months.

There is a sign of better times in the American Axe and Tool Company, of E. Douglas, Mass., which company is erecting two large iron shops



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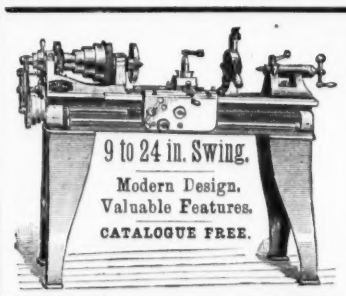

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to take the place of the one burned in October. Work will begin during March.

The Walter A. Wood Mowing and Reaping Machine Company, of Hoosick Falls, says, through the assistant secretary, that "The orders for the coming year are greatly increased over former years, and the prospect for another year's business is bright."—*Troy Times.*

The Demorest Manufacturing Co., Williamsport, Pa., have started up their works, and have large orders for the Demorest sewing machines, and their latest bicycles, which is one of the finest wheels made. The company also make open chain castings, and fine gray iron castings.

The Ruble Blower Co. is the name of a new company formed at Chicago, Ill., to manufacture pressure blowers, siphon exhausters, elevators and conveyors. The officers of the company are E. Cheney, president and manager; M. R. Ruble, vice-president; Frank L. Cheney, secretary; L. D. Condee, treasurer.

The large factory of the J. I. Case Thrashing Machine Company, Racine, Wis., which has been closed for the last five months, throwing 600 men out of employment, will start up with a full force February 19th. The Mitchell & Lewis wagon factory, employing 500 men, will also resume operations.

The Hathorn Fancy Forging Company has been organized in Bangor, Me., under the general law for the purpose of manufacturing and selling steel balls, lumbermen's driving calks, and all kinds of fancy forging in steel, iron and other metals, and to do a general manufacturing business in metals.

At Bridgeport, Ala., the proposed organization of a new company to operate Lowman Bros.' stove works has proven successful. E. H. Lowman has been elected president of the new company. The new concern has placed its capital stock at $25,000, and will operate under the title of the Bridgeport Stove Works.

An Elwood, Ind., dispatch says: Another large tin-plate factory has been located in this city, making three in all, with a combined output of twelve thousand boxes per week. The one located recently is backed by English capitalists, who have everything in readiness to begin work. Col. A. L. Conger will be a large stockholder in the new concern.

Complete systems of electric lighting, fire protection, and steam heating, are being put in at the following mills: Southern Finishing Mills, Greensboro, N. C.; Patterson Mills, China Grove, N. C.; Cannon Mills, Concord, N. C.; Cabarrus Mills, Concord, N. C.; Alpha Mills, Charlotte, N. C.; Duck Mills, Columbia, S. C.; Harmony Grove Mills, Harmony Grove, Ga.

The Peoria (Ill.) Steel and Iron Company is running its mill on full time, with plenty of orders still on hand. This company has been running its plant day and night for the past year, and it claims to be the only mill in the West that has been run through the financial crisis of the year. Some valuable additions have been made in the way of new machinery for finishing plow beams by tapering, shaping and footing.

A Joliet, Ill., press dispatch of January 30th, says: The rod mills of the Illinois steel mill have started up giving employment to 200 men. The converters have been run for one week with 900 men, and more will be put on next month. To-morrow, after a stoppage of two years, the rail-mill will start up, and it is now thought that the mills will run steadily for at least six months. Many smaller factories are commencing to run full turn.

A press dispatch from St. Louis, January 30th, says: The Valley steel plant at Belleville, Ill., resumed operations to-day with a full force of employes. Some of the machinery was set in motion last week and considerable work was done in preparation for the resumption to-day. For several days the former operatives, who left the city during the suspension, have been returning, and all those who intend to resume their places at the plant are now here, some 350.

The Inland Steel Company announce that their works at Chicago Heights, Ill., are now in operation, in charge of John W. Thomas, superintendent of the old Chicago Steel Works, which the new concern succeeds. The capacity is double that of the old works and specialties are made of bars, angles, tees, channels, agricultural shapes, harrow teeth and plow beams. The works are on the Outer Belt Line and shipments are delivered to connecting lines the day they leave.

Norton Bros., of River street, Chicago, are tearing out one of the old boilers at their Maywood factory, with view to putting in a new boiler and a new engine. The fly-wheel in use on the old engine, which is to be replaced, is historic, having been in use on the first water-works engine Chicago ever had. During the present year it is the firm's intention to consolidate their two great manufacturing plants by removing the River street factory plant to Maywood, where buildings will be erected alongside the present Maywood factory.

The following is from Haverhill, Mass.: That a business boom is in sight is now generally conceded in the shoe district. The output has not as yet shown a great proportionate increase, but numerous rush orders for the remainder of spring work are on hand, and the encouraging condition of affairs promises to continue. Besides orders for immediate delivery, the fall samples are out, and ready for inspection. Salesmen are departing West and South, and, so far as heard from, are being well received by jobbers.

The Ellwood Irvins' Tube Company, whose new plant is located a short distance from Oak Lane Station, on the Bethlehem branch of the Reading Railroad, started work February 5th with a force of 125 men. Mr. Irving said: "We expect in two weeks to double our force of employes. The works here will be carried on in connection with the old plant at Tenth and Spring Garden streets, where twenty-five men are employed. We have orders ahead that will keep us busy for the next six months. The tubing we manufacture is without seam, and varies from 5 inches to 1,100 of an inch in diameter, and from 50 to 150 feet in length, and is of steel, aluminum, bronze, copper, silver, gold and platinum.—*Labor Tribune.*

REDUCED PRICES OF

LeCOUNT'S LIGHT STEEL DOG.

No.	INCH.	PRICE.	No.	INCH.	PRICE
1	3/16	$ .35	8	2	$1.10
2	1/4	.35	Small set of 8—5.50		
3	3/4	.50	9	2 3/8	1.40
4	1	.60	10	3	1.50
5	1 1/4	.75	11	3 1/2	1.70
6	1 1/2	.85	12	4	1.90
7	1 3/4	1.00	Full set of 12—12.00		

C. W. LeCOUNT, South Norwalk, Conn.

These goods are for sale by CHAS. CHURCHILL & CO., L'td, 21 Cross St., London, England.

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INSIST ON HAVING
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VARIETIES FILES
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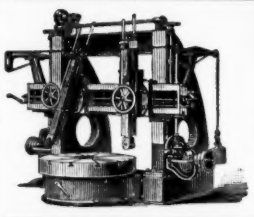

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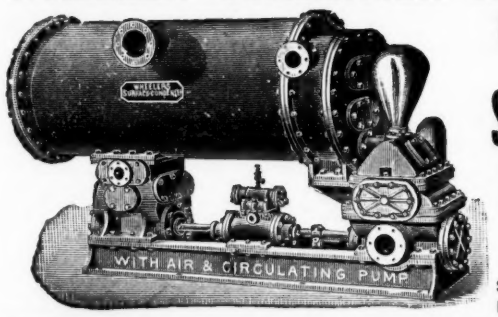

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The Wheeler Admiralty Condenser.
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Condensers for Electric Light and Power Stations, Mills, Mines, Ice and Refrigerating Plants. Condensers with and without pump.

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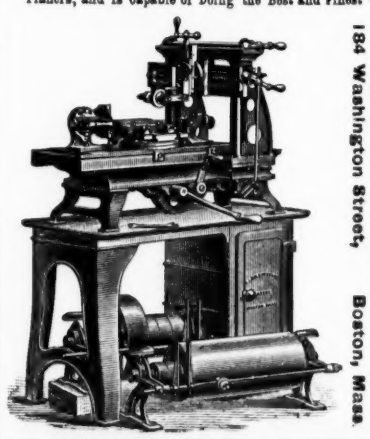
FOR MODEL MAKERS, EXPERIMENTAL WORK, &c.
Has all the Improved Features Usually Found on High Grade Planers, and is Capable of Doing the Best and Finest Work.



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FOR TOOLS, DRILLS, DIES, &c.
ALL KINDS IN STOCK.
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Established a century ago.
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ROPER'S PRACTICAL HAND BOOKS,
By STEPHEN ROPER, ENGINEER.
These books embrace all branches of Steam Engineering—Stationary, Locomotive, Fire, and Marine. Any Engineer who wishes to be well informed in all the duties of his calling should provide himself with a full set. They are the only books of the kind ever published in this country, and they are so plain that any Engineer or Fireman that can read can easily understand them.
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Screw Cutting Automatic Cross Feed, etc.
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Burnham's Sensitive Drill.

SEND FOR CIRCULAR.
THE GEO. BURNHAM CO., Worcester, Mass.

BUILDERS IRON FOUNDRY,
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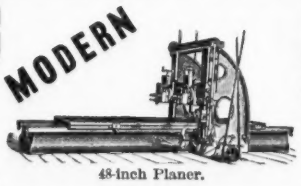
As an item of encouragement in quiet times, we take pleasure in announcing that we have received an order for 750 tons Machinery Castings for prompt delivery. Other orders, larger or smaller, are respectfully solicited. The character of our heavy castings and our facilities for machine work are suggested by the new 54-page pamphlet, "Our Share in Coast Defence—Part II," which is mailed upon application.

FITCHBURG MACHINE WORKS,
MANUFACTURERS OF THE CELEBRATED
FITCHBURG MODERN ENGINE LATHE
AND OTHER METAL-WORKING MACHINES,



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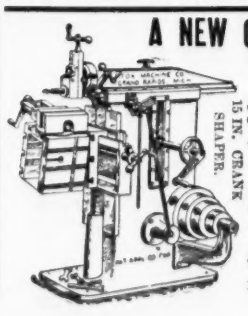

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Length of stroke changed INSTANTANEOUSLY while IN MOTION.
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135 Finsbury Pavement, London, England.

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Slow speeded, Force-blast, Durable, Compact and Cheap.
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WORTHINGTON CONDENSERS.
AGGREGATING IN CAPACITY
276,320
HORSE POWER
ARE NOW IN USE.
SEND FOR SPECIAL PAMPHLET.
HENRY R. WORTHINGTON,
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BOSTON, PHILADELPHIA, CHICAGO, ST. LOUIS, DENVER.

W. P. Davis, Rochester, N. Y., writes us: The manufacturing part of my business has been formed into a stock company, and the business of that company will date from February 1st The name of the company is "The W. P. Davis Machine Co." I am business manager of the company, C. F. Davis is superintendent, and has charge of the manufacturing. The shop and the machinery store have always been entirely separate, and there is no perceptible change in the business, although in the future, the store and the manufacturing department will be entirely separate, as I shall continue in the machinery and supply business as usual.

A dispatch from Bath, Me., dated February 13th, says: The Bath Iron Works caught fire at an early hour this morning. A strong wind was blowing, and many neighboring buildings were soon threatened. The entire fire department was summoned, and assistance was asked of neighboring towns. The steamer "Frank Jones" was lying at the wharf with no steam, and for a time was thought to be doomed. Efforts to get a tug to her in time were futile, and owing to the intense heat the volunteers attempting to pull her into the river were forced to abandon their work. As it was, she was badly scorched. Treasurer Hyde, of the Bath Iron Works, estimates the loss thus far at $40,000. Mr. Hyde says the firm will not rebuild, but will probably locate in New London, Conn. All that remains of the plant is the original machine shop, main office of the company, brass foundry and blacksmith shop. The two latter are badly scorched. From six hundred to seven hundred machinists and iron workers are thrown out of employment. The firm were getting out the wood and iron work for a new steamer, and all patterns are now lost, as well as the work completed and in process of completion. The works contained the finest shipbuilding machinery in New England.

The increase in foreign orders for milling machinery is noticeable among those progressive mill furnishers who reach out after this class of business One of the members of a firm of millers whose headquarters are at Odessa, Russia, but operating mills at many other points in the empire, in fact, the largest millers in Russia, when at the World's Fair, saw the bran packer in operation, which is manufactured by Nordyke & Marmon Company (Indianapolis, Ind.), and which formed a part of one of their exhibits, and was so favorably impressed with it that he ordered four packers to be shipped to Odessa. Seven more have been ordered, making eleven in all. These last ones go to different points in Russia, where they will doubtless be something of a revelation to the native miller unaccustomed to that neatness and efficiency which characterizes American milling appliances over the European productions. Among other recent foreign shipments made by Nordyke & Marmon Company is a fifty-barrel full roller mill to San Luis Potosi, Mexico; a large lot of special machinery and power connections to Paracuaro, Mexico; complete milling plant, including engine and boiler, to Chihuahua, Mexico; corn milling machinery to Australia, Hamburg, Germany, Brussels, Belgium, and a shipment of flour mill machinery to the Argentine Republic. They also have orders for milling machinery from Callipullo, Chile, and Bombay, India, and have just received an order for a complete roller process mill of fifty barrels' capacity from Orizaba, Mexico.—*Indianapolis Journal.*

Machinists' Supplies and Iron.

NEW YORK, February 14, 1894

Iron—American Pig—We quote Standard Northern brands, No. 1 Foundry, $13.00 to $14.00; No. 2, $12.50 to $13.25; Gray Forge, $11.75 to $12.50. Southern brands of good quality are obtainable at $13.00 to $14.00 for No. 1 Foundry; $11.75 to $12 50 for No. 2, and $10.75 to $11.25 for Gray Forge.

Antimony—The market is steady and quiet. We quote L. X., 9.30c. to 9.40c.; Cookson's, 10c. to 10½c.; Hallett's, 8.90c. to 9c., and U. S. French Star, 10c.

Lard Oil—Prime is quoted at 67c. to 68c.

Copper—The market is quiet, but steady, with no change in prices. Lake Copper is quoted at 9⅝c. to 9¾c. Casting Copper is held at 9¼c. to 9⅜c.

Lead—The market has a lower tendency. Quotations are from 3¼c. to 3⅜c.

Spelter—The market is sensitive; sellers are asking 3.87½c. to 3 90c. for New York delivery.

Tin—The market is inactive. Spot supplies are barely steady at 19.65c., and future deliveries favor buyers.

WANTED

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Wanted—Foremanship by one of exp; engines, pumps, or gen. repairing. Indicator, AM. MACH.

Draftsman, technically trained, 2½ years' mach. shop exp., wants position. Box 17, AM. MACHINIST.

Competent draftsman wants position. Marine engines preferred. Address Holmes, Ridgway, Pa.

Tool maker, exp'd, screw machine tools, cutters, punches, etc., wants position. Box 21, AM. MACH.

Young draftsman, graduate of college in Sweden, desires position Salary a secondary consideration. Address A., AMERICAN MACHINIST.

First-class mechanical draftsman. German, age, 26, six years' experience in steam engines and boilers, wants position; good refs. Box 19, AM MACH.

Wanted—Foremanship; exp'd in machine tool building; seven years as foreman; age, 31; can do drafting; the West preferred. "Chord," AM. MACH.

Wanted—Situation by a first class machinist, experienced in manufacture of steam engines, pumps, and special machinery; four years as foreman; references. Address Box 16, AMERICAN MACHINIST.

Situation wanted by a first-class tool dresser and steel worker; can do forging if required. Situation in the South preferred. Address Box 20, AMERICAN MACHINIST.

Wanted — Correspondence with firm needing traveling representative. Having first class mechanical training could readily adapt myself to any line. Address "M.", AMERICAN MACHINIST.

Wanted—Foreman for erecting and machine shop by a pump company manufacturing steam pumps. A good opening for a young man of energy and experience. State age, experience, and references. Address B., AMERICAN MACHINIST.

Wanted—Situation as superintendent by middle-aged man. Expert machinist, large and varied experience, irreproachable character, held the position of foreman and sup't with success for 25 years; best of reference. Superintendent AM. MACH.

Wanted—By a leading sewing machine company in Germany an able machinist, exp'd in the manufacture of sewing machines, to introduce the American system of "limited gauges" into their works. Knowledge of German is not necessarily required. Address R. S., AMERICAN MACHINIST.

Wanted—Situation by expert all-round machinist as foreman, assistant, or responsible position as first-class machinist. Exp'd on engines, general and special machine work. Developing inventions, designing jigs, etc., for expediting and duplicating work. JOHN T. USHER, BOX 22, AM. MACHINIST.

✢ MISCELLANEOUS WANTS ✢

Advertisements will be inserted under this head at 35 cents per line, each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Cheap 2d hd lathes & planers. S. M. York, Clev'd, O.

Best Steel Flue Scrapers. Kelley Co., Erie, Pa.

For Sale—Second-hand drill presses, engine lathes & planers. Dietz. Schumacher & Co., Cincinnati, O.

Light and fine machinery to order; Foot Lathe Catalogue for stamp. E. O. Chase, Newark, N. J.

Calipers, Surface Gauges, etc. Catalogue free. Send for it. F. A. Welles, Milwaukee, Wis.

Wanted—Patterns to make. Estimates made on application to Wattles Gas Eng. Co., Elizabeth, N. J.

Wanted to arrange with some responsible manufacturing concern to put on the market a new gas engine which is entirely novel in gas engine practice. Box 13, AMERICAN MACHINIST.

Wanted—An Allen pneumatic riveting machine, such as is used for beam and bridge work. Second-hand machine preferred. Address The Castle Ice Machinery Co., Indianapolis, Ind.

We will pay 50 cents each for copies of the AMERICAN MACHINIST of December 4, 1886 issue; must be unsoiled and in good condition. AMERICAN MACHINIST PUBLISHING COMPANY, 203 Broadway, New York.

Introduction and negotiation of American patents and machinery to English manufacturers and agents. Write for circular to Geo. Richards. M. I. M. E., Mechanical and Consulting Engineer, No. 5 Laurence Pountney Hill, London, England.

Wanted—By a well-known English firm, a patented engineering specialty, to manufacture and sell in England and colonies. State full particulars to "N.", care T. B. Browne's Advertising Agency, 353-355 Canal Street, New York.

Michigan Agricultural College offers instruction in mechanical engineering—four years' course; the average expense of attendance at the college is $135 per year; the course is arranged so as to give students an opportunity to earn a portion of their expenses. Address Mechanical Department, Agricultural College P. O., Mich.

Established in 1874.

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93 in. Hydraulic Riveting Machine, Pump and Accumulator.
10 Ton Crane Bridge, 24 ft. x 20 ft.
Plate Planer, 16½ ft., one setting. 1 in. Plate.
Shear No. 27, 30 in. throat, ¾ in. plate.
Above entirely New, made by Bement, Miles & Co.

— ALSO —

Boiler Rolls, 8 ft. 3 in between Housing. Cheap.
Punch, 21 in. throat. Teal.
60 in. Swing Post Drill. Hilles & Jones.
Full Line Lathes, Planers, Drills, Milling Machines, Screw Machines, Shapers, Profiling Machines, etc.
No. 3 Stiles Press.
Lot of **Polishing Machinery, Dynamo** for Electro-plating, Drop Hammer, Belting, etc., etc.

Send for December List of Machinery on Hand.

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FOR SALE.

An iron building, lately used as a Glass Works, now standing at Lenoxdale, Mass., same being 18 ft. height of post, by 80 ft in width. by 300 ft. in length. Same will be sold for but little more than the price of scrap iron, either as a whole, or in parts to suit, taken down and loaded on cars complete, ready for erection. Price and further particulars upon application to

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SEND FOR CIRCULAR.

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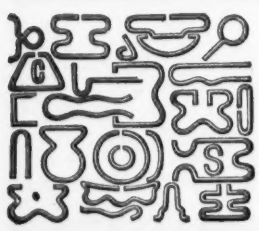

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Builders of WIRE FORMING MACHINES

With F. B. Manville's Patent Sliding Former,

For making articles from the coil, of either round, half round, flat, or square wire, similar in shape to those shown in the cut herewith. Also similar articles made to order.

Send samples of articles required, and mention quantity wanted, that we may quote prices for either machine or the goods, whichever may be desired.

Bicycle and Labor Saving Machinery a Specialty.

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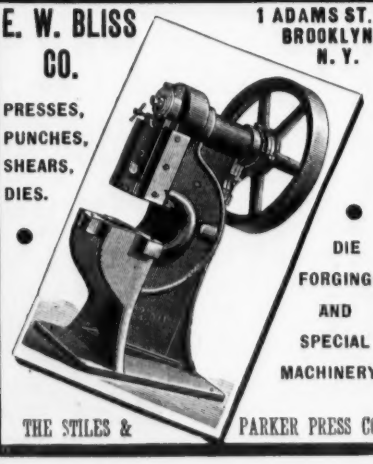
PRESSES, PUNCHES, SHEARS, DIES.



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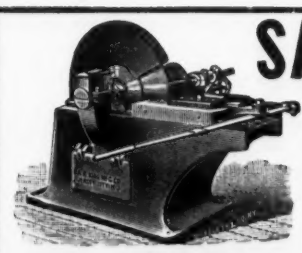
THE STILES & PARKER PRESS CO.



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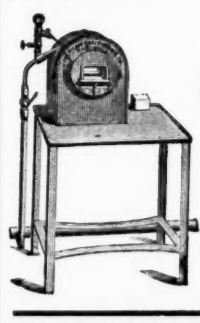
MACHINERY AND TOOLS.
Heavy Machine Castings.



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OIL GAS PLANTS

GAS BLAST FURNACES and HIGH PRESSURE BLOWERS

For the economical generation and systematic application of HEAT.

CATALOGUES ON APPLICATION.

No. 80 NASSAU STREET, NEW YORK.

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SOLE MANUFACTURERS OF

GRAHAM'S GROOVED SHANK TWIST DRILLS AND CHUCKS.

Endorsed by Practical Mechanics Everywhere. Send for Catalogue

(Over 5,000 in Use.)

BEAM CALIPERS

IN 5 SIZES
Any graduation.
Also Vernier and Metric System.
WARRANTED ACCURATE.

Ask your dealer for them or send for circulars and prices to E. G. SMITH, Columbia, Pa.

SECOND-HAND MACHINE TOOLS.

ENGINE LATHES.

1 15 in. x 5 ft. Flather.
1 15 " 6 " Jones & Lamson.
2 15 " 7 " S. C. Wright.
1 15 " 8 " Fitchburg.
1 16 " 7 " Bement.
1 16 " 6 " New Haven.
7 16 " 6 " F. E. Reed.
2 16 " 8 " F. E. Reed.
2 16 " 6 " Prentice Bros.
1 16 " 6 " Perkins.
2 16 " 8 " Wm. Munzer.
1 20 " 6 " E. P. Bullard.
20 in. x 10 ft. Putnam.
1 26 in. x. 10 ft. New Haven.

PLANERS.

1 15 in. Lathe and Morse Crank.
1 20 in. x 20 in. x 6 ft. Pratt & Whitney.
1 22 in. x 22 in. x 4 ft. Pond.
1 24 in. x 24 in. x 5 ft. New Haven.
1 28 in. x 28 in. x 7 " " "
40 in. x 40 in. x 9 ft. Pond Mach. T. Co.

SHAPERS.

1 6 in. Boynton & Plummer,
1 10 " " "
2 15 " Juengst, Friction.
1 24 " Hendey, Friction.
2 15 " Wood, Light & Co.
1 18 " Putnam, Traverse Head.

DRILL PRESSES.

2 10 in. 3-Spindle Slate.
2 Garvin, Bench.
2 Garvin, No. 2, 4-Spindle.
1 Pratt & Whitney, 3-Spindle.
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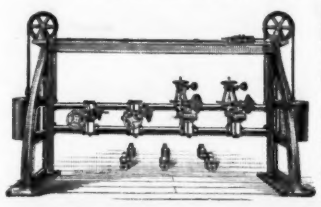

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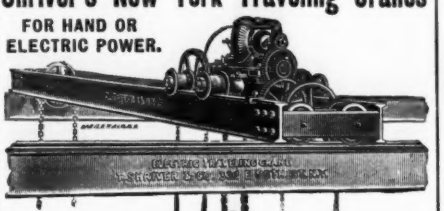

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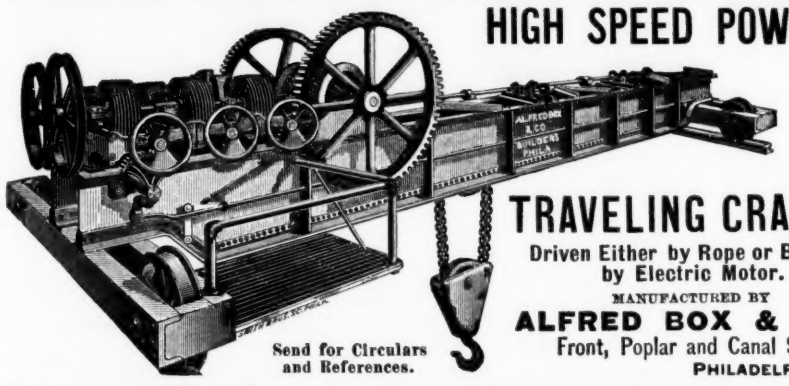

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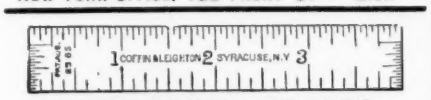

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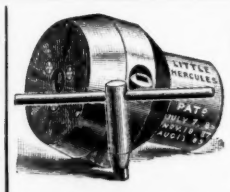

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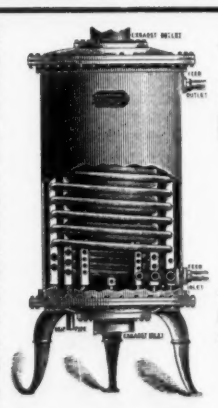

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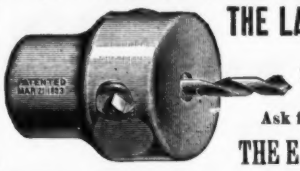

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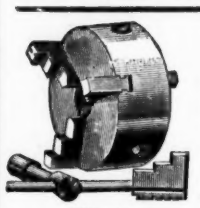

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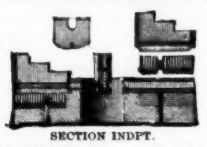

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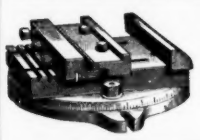

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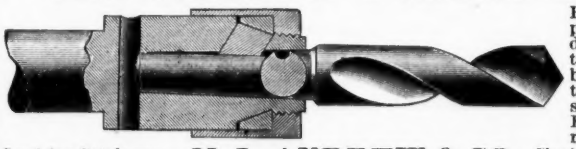

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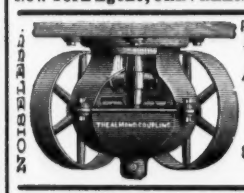

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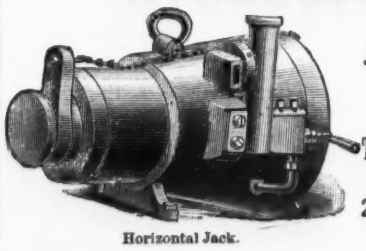

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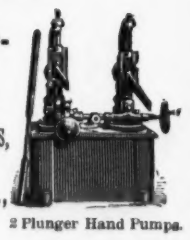

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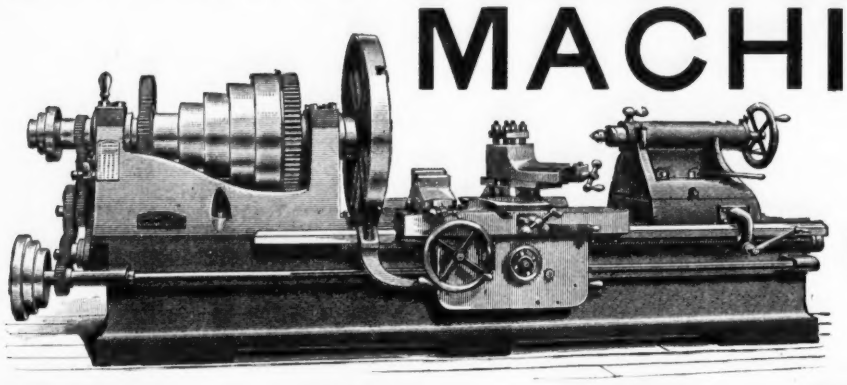

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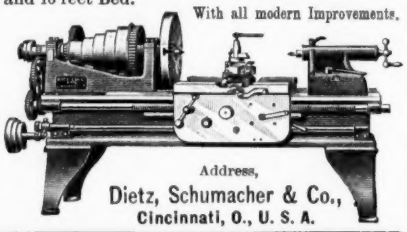

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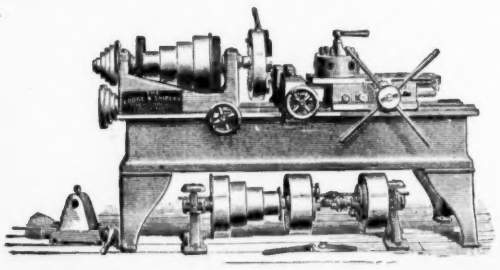

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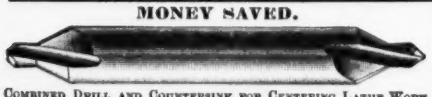

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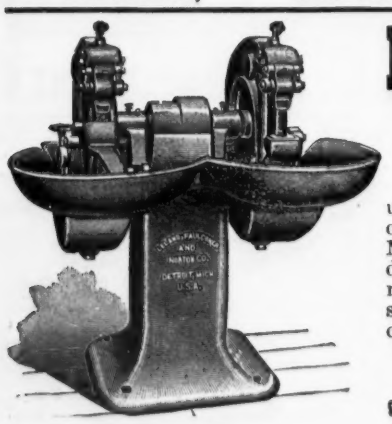

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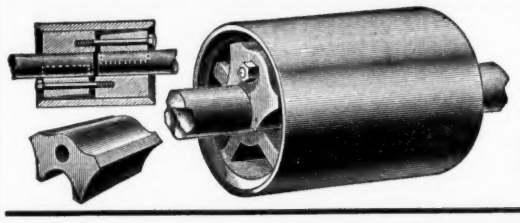

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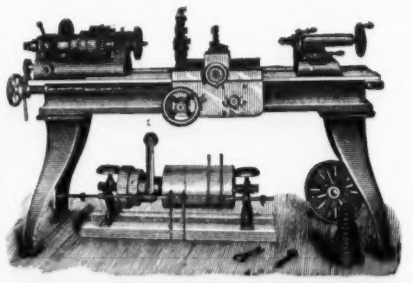

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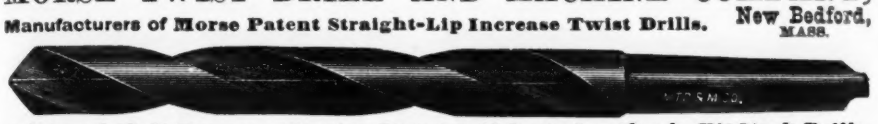

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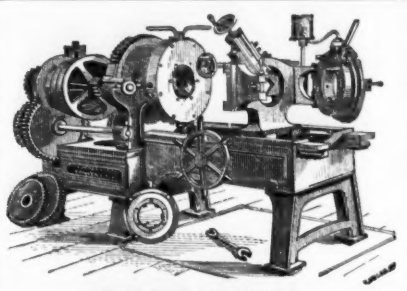

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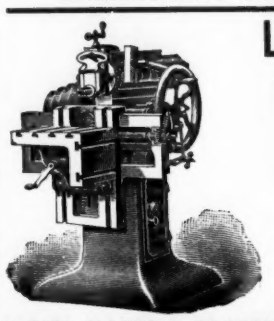

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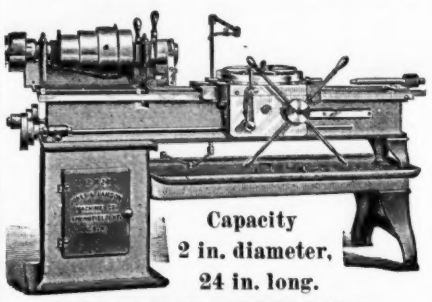

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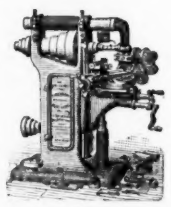

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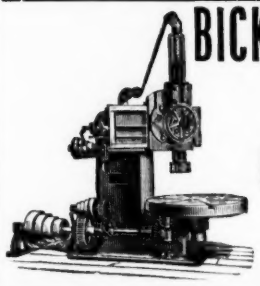

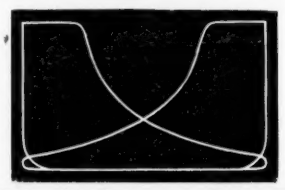

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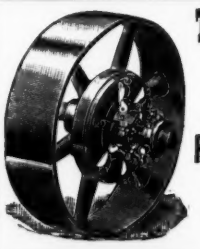

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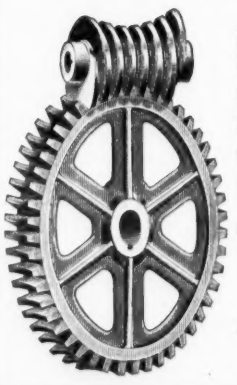

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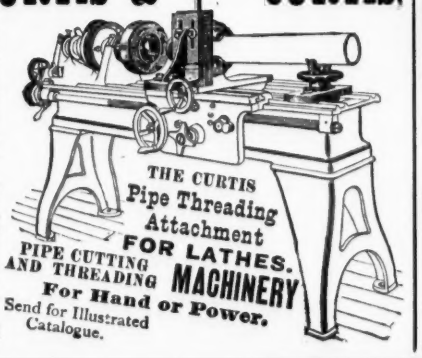

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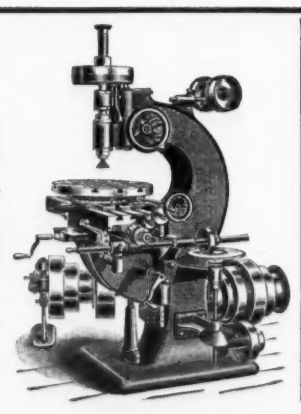

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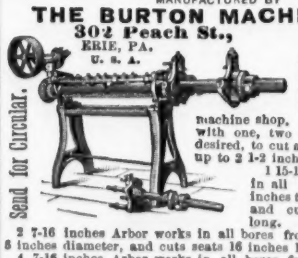

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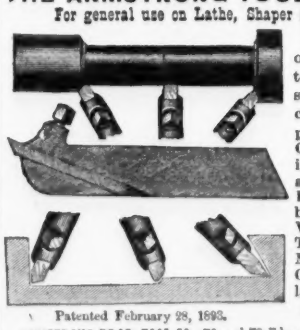

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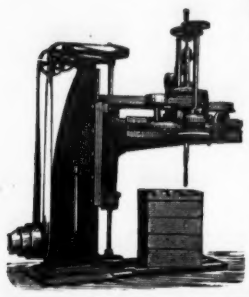

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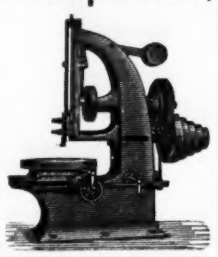

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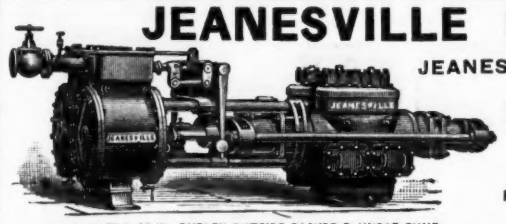

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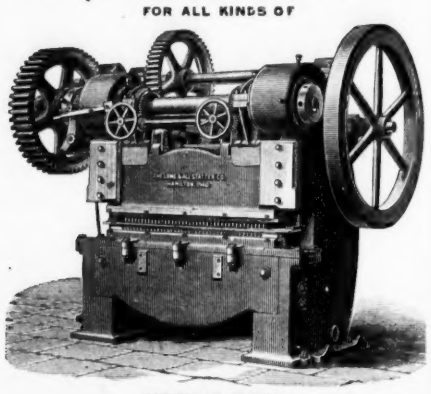

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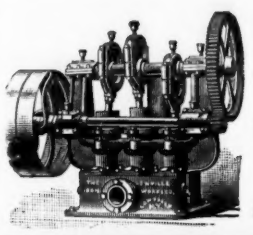

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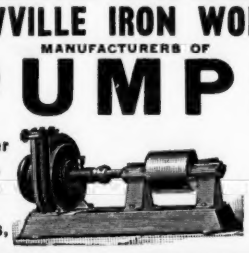

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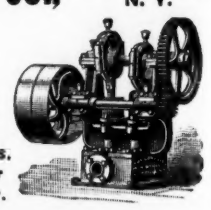

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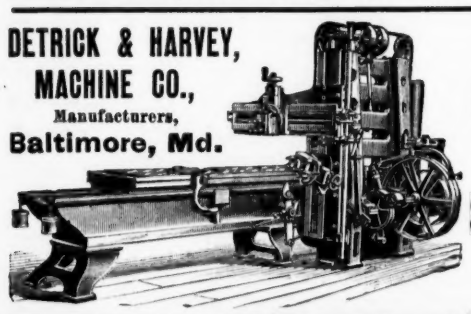

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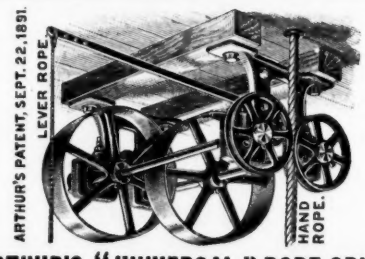

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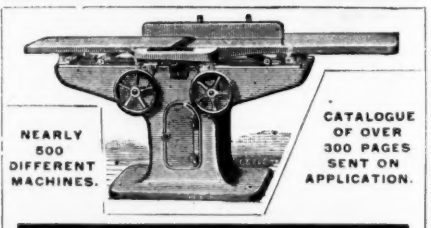

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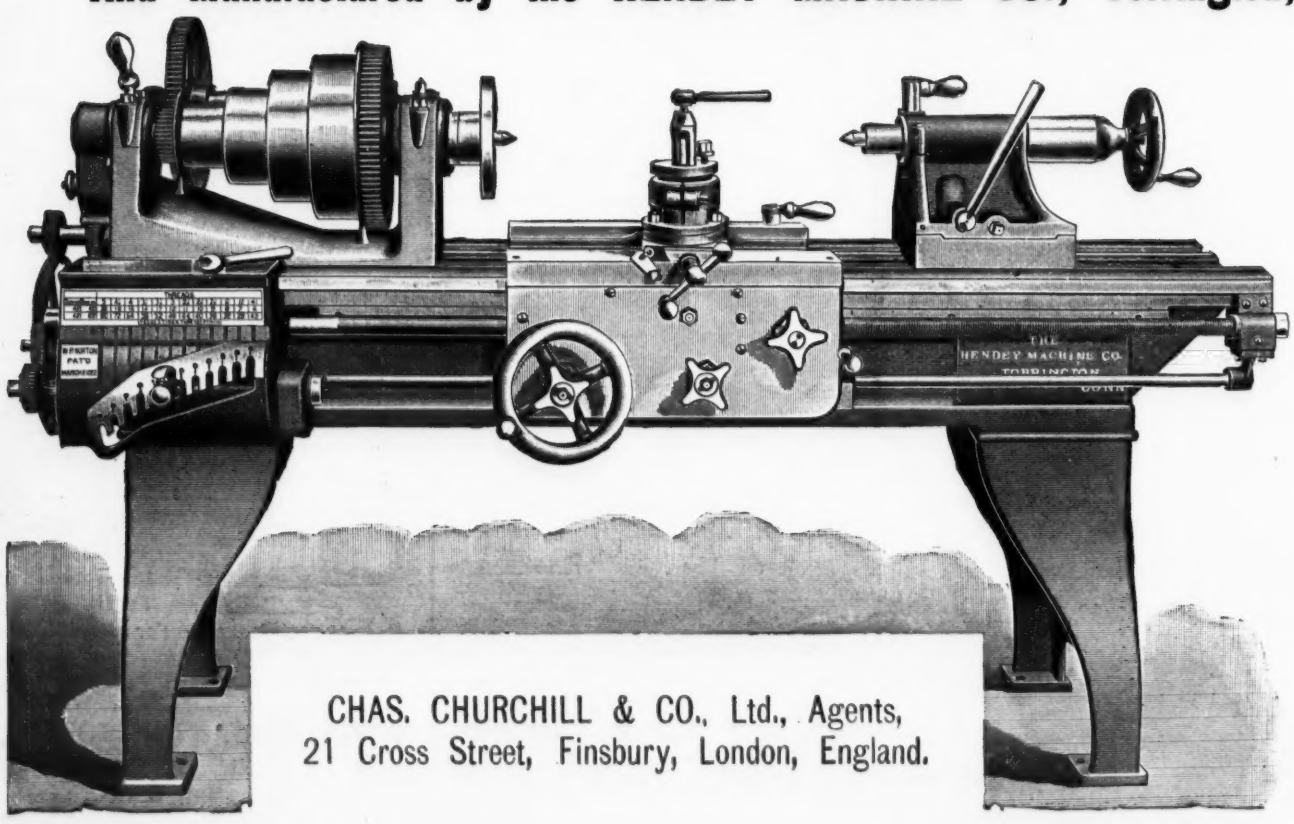

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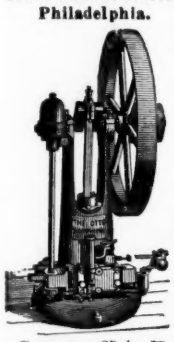

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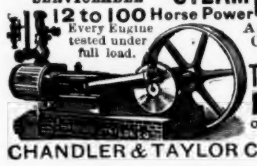

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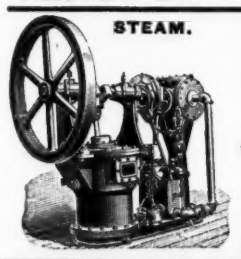

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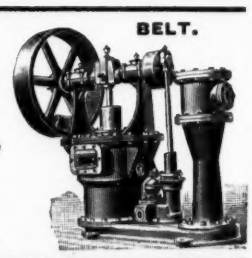

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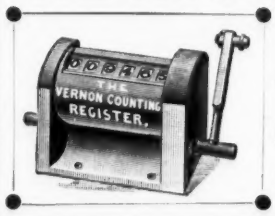

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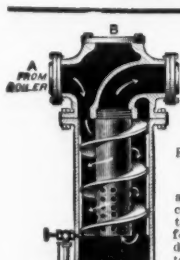

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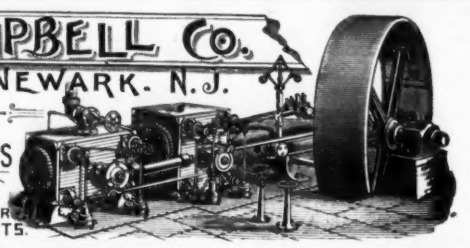

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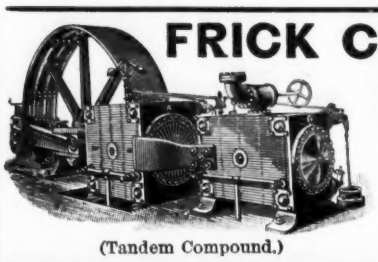

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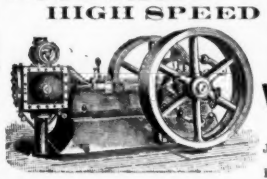

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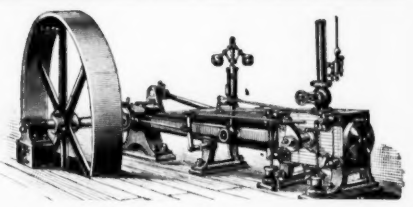

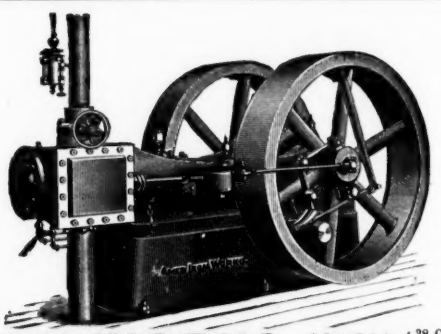

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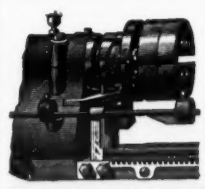

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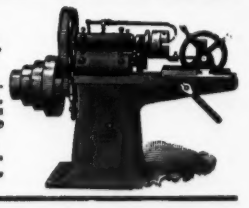

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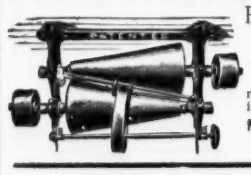

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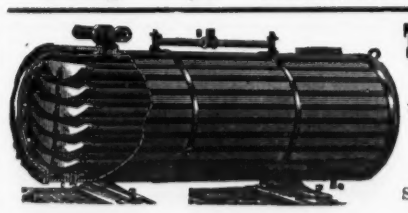

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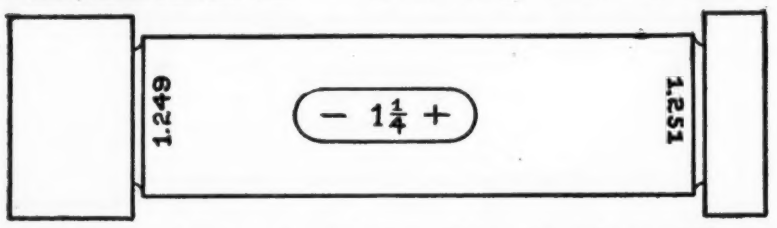

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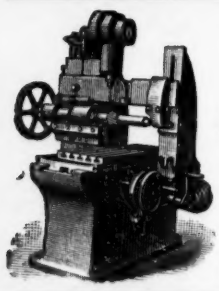

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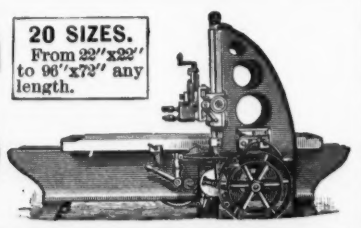

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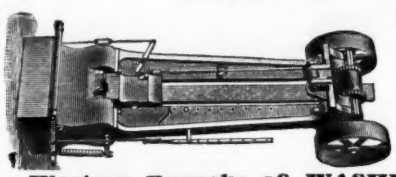

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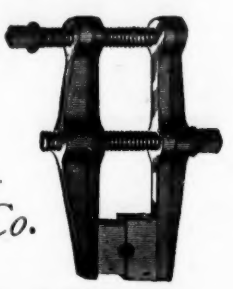

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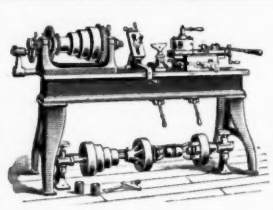

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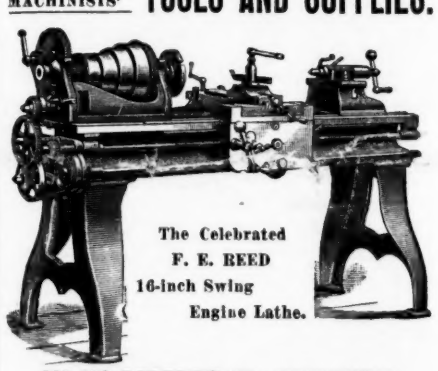

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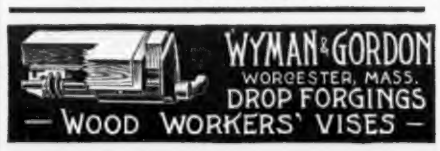

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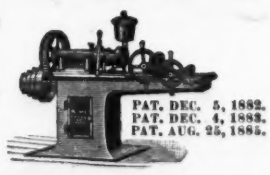

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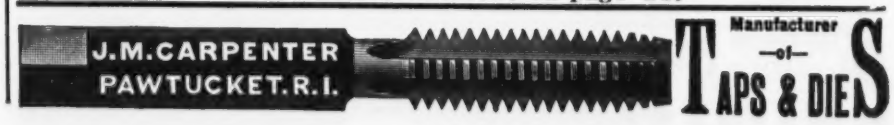

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